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# PYOPERICARDITIS

## AN ANALYSIS OF CASES TREATED BY PERICARDIOTOMY*

J. Dewey Bisgard, M.D.

CHICAGO

VERY comprehensive historical reviews, with summation of our present knowledge of purulent or suppurative pericarditis, have been recorded in recent years by Alexander, Winslow and Shipley, Lockwood, and others. Following the inception of surgical drainage of the pericardial sac with Hilsmann, cases have gradually accumulated in the literature and have been periodically collected.

Alexander, Williamson, and Winslow and Shipley, all working independently, compiled cases reported in the literature for the interim dating from Pool's collection in 1921 until approximately May, 1927, reporting totals of 126, 117, 128 cases respectively. To add to Alexander's collection the 10 personal cases reported by Winslow and Shipley and 1 reported by Williamson, the combined series represents 137 cases. Herewith, an endeavor has been made to advance chronologically this assemblage to the present writing, May, 1931, and to report 2 cases observed and treated by pericardiotomy by the author. During this period of four years 32 cases were reported, establishing a grand total of 171 cases, with 77 early deaths (45 per cent mortality) and 94 recoveries.

This comparatively small group of cases is in no way representative of the incidence of purulent pericarditis. However, its infrequent occurrence can be judged by the findings of Barkan and Lucas who, in a review of 3248 autopsies reported at the Harvard Medical School, found only 6 cases. Stone recorded an incidence of 44 (15.5 per cent) in 300 post-mortem examinations performed on patients who died of pneumonia.

Purulent pericarditis, as well as pericarditis in general, was characterized by Osler as the most commonly overlooked serious disease. Abundant corroborative evidence of this statement exists in the literature. Of 68 cases reported by Cabot (1926) 7 only were diagnosed during life and he states that of all cases observed at post-mortem examination at the Massachusetts General Hospital 77 per cent had not received clinical recognition. Reporting from the same hospital, Whittemore found that only 2 patients came to operation over a period of thirty-two years. Poynton, in an investigation of necropsy reports of 100 cases of purulent pericarditis, found that in only 6 cases had the condition been recognized before death. These facts find justification in that in many instances the pericardial involvement enters the clinical picture only as a terminal event, or its presence is obscured by the magnitude of the primary disease process.

With the single exception of direct bacterial inoculation from trauma, such as

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puncture wounds, suppurative pericarditis is always secondary to an adjacent or remote infective focus. Its frequent association with pneumonia and empyema suggests an infection by direct extension. Communicating sinuses between the pericardial cavity and the esophagus, and the pericardium and adjacent pyogenic, tuberculous, and actinomycotic abscesses are on record. As a complication in remote suppurative processes such as osteomyelitis a hematogenous interrelationship must be assumed. However, coexisting metastatic abscesses in the heart muscle have been observed and Thomas feels this myocardial involvement is responsible for the high mortality rate concurrent in this group of cases.

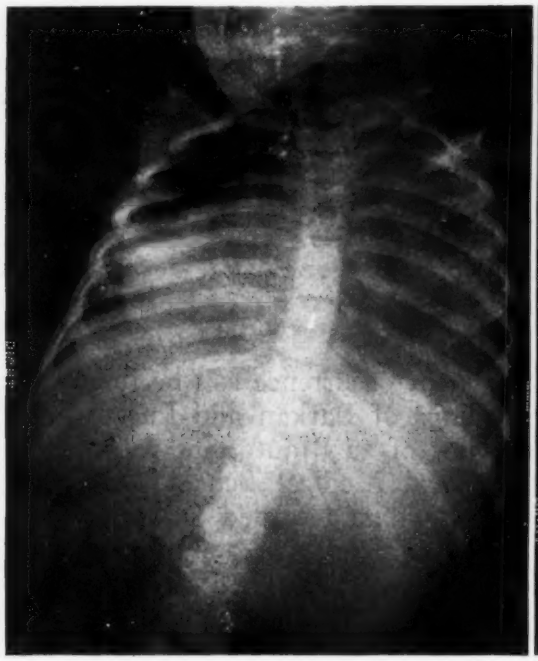

Fig. 1, Case 1. Massive empyema of left pleural cavity displacing heart and mediastinum into right chest.

Fig. 2, Case 1. Same case seven days after institution of closed drainage of left pleural cavity.

Purulent pericarditis as a secondary entity is essentially a disease of the first three decades of life. Of the 171 reported cases, 124 occurred in persons under thirty years of age. The male sex predominated in the ratio of 3 to 1. An etiological analysis of all reported cases has been compiled in Tables I and II.

The pathological picture presented by purulent pericarditis differs from that of serous cavities elsewhere only in respect to its relation to the heart. The constant churning action of this organ tends to impede the formation of inflammatory adhesions and often causes fibrin to be deposited on the heart and parietal pericardium in concentric rings and layers comparable to the architectural structure of an onion. The shaggy heart is classical.

Purulent pericarditis, aside from the fairly obvious primary traumatic infections, should always receive consideration in the presence of unexplained symptoms of infection (temperature elevation and leucocytosis) or the continuance or recurrence of these symptoms after a crisis in pneumonia or the establishment of adequate drainage in cases of empyema or osteomyelitis. The physical signs and symptomatology are best classified in respect to the causative pathological physiology. A brief enumeration with percentage frequency as calculated from the entire collected series follows. Many histories

were brief and related in general terms so that at best these figures are merely relative, and only to this extent have value.

tory. It was reported in only 12 per cent of the series, but most cases were not observed at the onset.

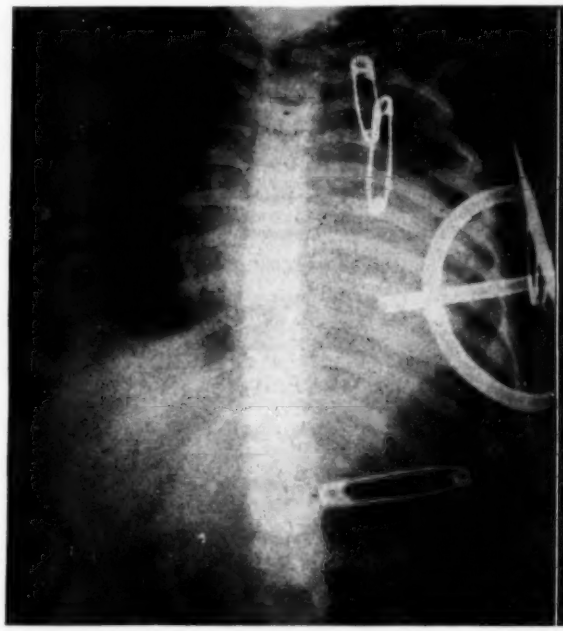

Fig. 3, Case 1. Globular enlargement of heart shadow characteristic of pericardial effusion. Drainage tube is in left pleural cavity.

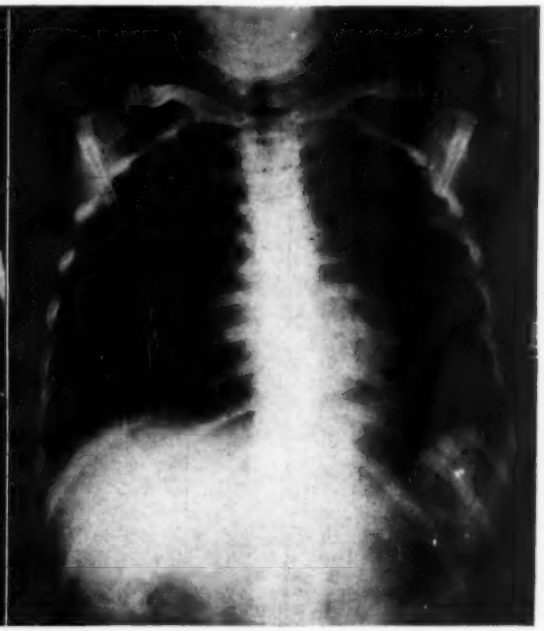

Fig. 4, Case 1. Same case one year after pericardiotomy.

These analyses may be grouped under four headings:

1. Signs and symptoms of the associated primary exciting focus (pneumonia, empyema, osteomyelitis, etc.). Dissociation of symptoms with recognition of the coexisting lesions is frequently difficult.

II. Signs and symptoms in response to infection. These vary with the degree of toxemia produced by the invading microorganisms and do not differ from those resulting from infection elsewhere in the body. The marked circulatory disturbance, cyanosis, and dyspnea are so strikingly out of proportion to the temperature and other symptoms of toxemia that a lesion of the center of circulatory function should be suspected. Sixty-two per cent of the reported cases had an elevation of temperature, usually not great.

III. Signs and symptoms resulting from the local inflammatory process.

1. A to and fro friction rub is frequently heard at the onset and is invariably transi-

2. Precordial and epigastric pain and distress are apparently not infrequent (15 per cent).

3. Cyanosis (50 per cent).

4. Dyspnea (48 per cent). May be constant or paroxysmal.

5. Tachycardia and arrhythmia (74 per cent).

The three latter symptoms are produced, at least partially, by the abnormal cardiac stimulation and the associated toxic myocarditis. They were strikingly in evidence in the 2 cases observed by the author.

IV. Signs and symptoms resulting from the presence and pressure of the accumulated exudate. As the fluid increases the normal area of cardiac dulness becomes increased in all dimensions. This was recorded in 72 per cent of the cases. It also becomes distorted in respect to the variable distensibility of the pericardial sac which amasses the fluid principally at the base and posteriorly. In consequence there is:

1. A disproportionate broadening of the base.

2. An extension of the dulness to the left beyond the apex beat and to the right of the right sternal margin with obliquation of the cardiohepatic angle (Rotch's sign).

TABLE I
ETIOLOGICAL CLASSIFICATION OF ALL REPORTED CASES

| | Recoveries | Deaths | Total |
|---|---|---|---|
| 1. Pneumonia | 29 | 18 | 47 |
| 2. Pneumonia and pleurisy, pneumonia and empyema | 8 | 13 | 21 |
| 3. Empyema | 4 | 5 | 9 |
| 4. Septicemia | 0 | 3 | 3 |
| 5. Pyemia | 3 | 4 | 7 |
| 6. Osteomyelitis | 8 | 10 | 18 |
| 7. Puerperal sepsis | 2 | 1 | 3 |
| 8. Childhood diseases, scarlatina, measles, etc. | 4 | 3 | 7 |
| 9. Trauma, stab and gunshot wounds | 16 | 1 | 17 |
| 10. Tonsillitis, septic sore throat, (otitis media and mastoiditis) | 5 | 2 | 7 |
| 11. Pleurisy | 2 | 2 | 4 |
| 12. Actinomycosis | 0 | 2 | 2 |
| 13. Inflammatory rheumatism, arthritis | 3 | 0 | 3 |
| 14. Influenza | 2 | 3 | 5 |
| 15. Perforation of tuberculous cavities | 0 | 1 | 1 |
| 16. Esophageal perforation | 0 | 1 | 1 |
| 17. Mediastinitis | 0 | 1 | 1 |
| 18. Typhoid fever | 0 | 1 | 1 |
| 19. Pulmonary gangrene | 0 | 1 | 1 |
| 20. Erysipelas | 1 | 0 | 1 |
| 21. Not stated | 7 | 5 | 12 |
| | 94 | 77 | 171 |

TABLE II
BACTERIOLOGY

| | Recoveries | Deaths | Total |
|---|---|---|---|
| 1. Pneumococcus | 32 | 13 | 45 |
| 2. Staphylococcus | 10 | 7 | 17 |
| 3. Streptococcus | 12 | 11 | 23 |
| 4. Influenza bacillus | 0 | 1 | 1 |
| 5. Colon bacillus | 1 | 0 | 1 |
| 6. Mixed pyogens | 2 | 2 | 4 |
| 7. Unclassified | 2 | 3 | 5 |
| 8. No growth | 5 | 1 | 6 |
| 9. Not stated | 30 | 39 | 69 |
| | 94 | 77 | 171 |

3. Absent or muffled heart sounds and apex impulse (58 per cent).

4. Limitation of movement of the left chest and a positive Hoover's sign.

5. Signs of lung compression posteriorly (Bamberger's sign) (20 per cent).

6. Precordial bulging with widening of the interspaces in children (8 per cent).

7. A characteristic posture of sitting upright and leaning forward (21 per cent).

8. A somewhat distinctive cyanosis associated with pallor. (Dyspnea, arrhythmia, tachycardia, and precordial pain have mechanical as well as reflex sources so bear repetition under this heading. Williamson, Blake, Rhodes, and Parker all relate experiences in which irrigating solution introduced after the establishment of drainage had not returned but had accumulated within the pericardium and resulted in increased interpericardial pressure with the onset of the symptoms of cardiac embarrassment described above. Kuno and Hietler by experimental irritation and electrical stimulation produced similar phenomena.)

A group of less constant pressure symptoms were reported too infrequently to be given percentage recognition:

1. A dry reflex cough.
2. Dysphagia.
3. Hiccough.
4. Vomiting.
5. Aphonia.
6. Engorgement and visible pulsation of the jugular veins and dilation of the superficial veins of the thorax.
7. Enlargement of the liver.
8. Ewart's first rib sign.
9. Horner's syndrome.
10. Precordial tenderness and edema.

With progression of the pericarditis frank heart failure ensues, with exaggeration of the cyanosis and dyspnea, and the development of general passive congestion and edema.

The roentgenograms as reported in 25 per cent of the cases registered rather characteristically enlarged heart shadows. Holmes summarized his observations:

1. An abnormally shaped and enlarged heart shadow which changes with alteration of the position of the patient, a sign not present in any other condition.

2. Obliteration of the normal heart outlines.

3. Change in the shape of the angle formed by the posterior border of the heart, the diaphragm, and the spine.

4. Faint or absent pulsation with fluoroscopic visualization. With the induction of pneumopericardium, Harloe was able to demonstrate a fluid level shadow and a thickened pericardium.

The electrocardiograph and other instruments of precision offer no assistance in the verification of the diagnosis of pericarditis.

The mortality rate in purulent pericarditis without operation closely approximates 100 per cent. Dujol and Aritzenius however have reported cases of patients who completely recovered after one drainage by pericardiocentesis. With adequate surgical drainage, as indicated by an analysis of all reported cases, this rate has been reduced to 45 per cent. There appears to be very little evidence forthcoming of permanent residual cardiac damage. In only 3 cases was symptomatic evidence of an adhesive pericarditis reported.

The differential diagnosis invites a consideration of such conditions as hemorrhagic or simple serous pericardial effusions, cardiac hypertrophy or dilatation, empyema (encapsulated), mediastinal neoplasms, mediastinitis, subdiaphragmatic abscess, coronary accidents, and penetrating ulcer. Le Conte and Roberts feel that as an assistance in the establishment of the diagnosis pericardiocentesis, carefully and skilfully performed, is a very simple and essentially harmless procedure, despite opinions to the contrary by Coutts, Ballance, and Rhodes. Matas mentions nine deaths resulting from puncture of the heart in the performance of pericardiocentesis. The pericardium is probably most safely approached with an aspirating needle through the left costal xiphoid angle. Infection of the pleural cavity is rarely caused by this procedure, but not infrequently follows pericardiotomy.

There is a unanimous agreement that pericardiocentesis as well as expectancy commands no place in the treatment of suppurative effusions. The early establishment of free and dependent drainage is indicated. In its accomplishment six methods of approach have been used.

1. Simple intercostal incision. The inadequacy of drainage has resulted in its general abandonment except as a means of inserting a catheter for drainage and irrigation. This has been accomplished through a trocar as in closed intercostal thoracotomy for empyema.

2. Resection of one or two of the left costal cartilages ranging from the fourth to the eighth inclusive. The internal mammary vessels are divided or retracted medially and the pleural reflection pushed laterally if necessary. This probably is the procedure of choice for most cases.

3. Resection of corresponding costal cartilages on the right side of the sternum. Shipley and others on occasion have found it expedient to use this approach, but its employment should rarely be necessary.

4. Trans-sternal. The pericardium is readily exposed through a trephine opening in the lower portion of the sternum. The limited opportunity for exploration of the pericardial cavity presents a great disadvantage.

5. Xiphocostal (Larrey) and epigastric routes provide most dependent drainage, and on this basis have many advocates. In the latter, the peritoneum is reflected downward and the pericardium exposed through the diaphragm at the junction of its sternal and costal attachments.

6. Posterior approach. This has been used to gain access to a collection of pus in the posterior pericardial recess by either traversing compressed lung tissue or an empyema cavity. Louchs has reported 2 cases of patients successfully drained by this approach.

Once adequate drainage has been established its maintenance must be assured until the pericardial sac has become relatively sterile. Considerable variance in the methods used to gain this end and controversial opinions appear in the literature. Shipley, who enjoys a wider experience with pericardiotomy (11 cases) than any other surgeon, advocates open drainage through a trans-sternal approach in children and a xiphocostal approach in adults with the insertion of Dakin's tubes into the most dependent portion of the pericardial sac. He stresses the necessity of exploring the entire confines of the pericardium with the finger to open up any possible walled-off abscess. Air-tight closed drainage with frequent irrigation of saline or Dakin's solutions through an inlying catheter has been used by Harloe and Bowers. Negative pressure drainage has been employed by Whittemore. Various forms of rubber tubing and gauze packs have been utilized. Equally effective drainage has been accomplished without the insertion of any foreign body but merely by suturing the pericardium to the skin or subcutaneous tissue. Peterson secures dependent drainage by means of posture, that is, turning the patient on his face periodically.

Fig. 5, Case 1. One year after operation. Pericardiotomy scar shows slight retraction synchronous with systole.

The observations made by Beck and Cox suggest that definite physiological advantages are to be gained by the air-tight method of drainage. Experimentally, they demonstrated that cardiac efficiency was considerably reduced by tamponage when exposed to atmospheric pressure. Metivet, Harrigan and Ljunggren report cases in which the heart ceased beating simultaneously with the opening of the pericardium, the "stand-still" heart. Return of function was attributed to massage, mechanical stimulation, and in 1 case, the injection of ephedrine.

## CASE HISTORIES (AUTHOR'S CASES)

Case 1. Recovery. M. S., an emaciated white female child, aged six years, was seen in consultation and referred to the hospital February 25, 1930, with a diagnosis of post-pneumonic empyema of the left pleural cavity. The preceding history can be summarized as essentially unimportant until the onset of an upper respiratory infection four weeks previously. This was followed by a left lower lobar pneumonia terminating in two weeks with a pseudo-crisis and then by lysis.

A week before admission, the temperature elevation and other symptoms of a toxemia recurred. Signs of a pleural effusion developed rapidly in the left side of the chest. Pleurocentesis was done with aspiration of thick creamy pus containing pneumococcus in smear and culture (not typed). The roentgenograms (Fig. 1) indicated a massive effusion of the left pleural cavity with displacement of the mediastinal structures into the right side of the chest.

Upon the patient's admission the temperature was found to be 103.2°F. (R), respirations 52, the pulse 148, leucocytosis of 28,000 and the

red blood cells numbered 4,000,200. The urine was negative. A closed intercostal drainage of the left pleural cavity was immediately instituted. This was followed by a prompt amelioration of symptoms and an afebrile course from the third to the tenth postoperative days. Figure 2 represents the *x*-ray findings seven days after operation. On March 7, ten days postoperatively, there was a rather sudden onset of cyanosis, dyspnea, restlessness, tachycardia, a desire to sit up and a mounting temperature of 102.6°F. (R). There was a marked irregularity of the rhythm and volume of the pulse and a definite to and fro friction rub. The heart sounds were distinct. On the following day, the patient's condition was greatly improved. The friction rub had disappeared and the circulatory disturbance was much less pronounced. During the next two days, the temperature began to picket from 99.6° to 103.8° (R), a dry hacking cough developed, dyspnea increased, and the patient chose a sitting posture with the head resting forward on a pillow. By the third day there was a marked pallor with the cyanosis (a livid hue), restlessness, and an anxious facial expression. The pulse (160 plus) was of poor volume and markedly irregular, the heart sounds were barely audible, and the apex impulse could not be obtained. The left chest bulged somewhat and did not move as freely as the right. The superficial veins were dilated. The area of cardiac dulness as outlined by percussion extended in a straight line 3 cm. to the right of the right sternal margin from the liver dulness below to the first interspace above, and to the left 3 cm. in the second interspace and the anterior axillary line at the apex. The base measured approximately 8 cm. at the second interspace. There were dulness and diminished breath sounds and tactile fremitus over the entire left chest posteriorly. The roentgenogram taken at this time and shown in Figure 3 was characteristic of a pericardial effusion. Fluoroscopic visualization showed absence of pulsation of this greatly enlarged globular heart shadow. The urine was negative, the white blood cells numbered 32,000, the blood culture was reported "no growth," and the blood pressure was 82/56 mm.

March 11, 1930, a pericardiocentesis (needle introduced at the xiphocostal angle and directed inward and upward) yielded approximately 400 c.c. of seropurulent fluid (bacteriologically pneumococcus). There was an immediate marked improvement in the patient's condition. Two hours later with local anesthesia the fourth and fifth left costal cartilages were exposed through a curvilinear incision and both cartilages removed. The pericardium immediately presented into the wound. The internal mammary vessels were retracted and the pericardium incised. Considerable seropurulent fluid, containing a few flecks of fibrin, welled up into the wound with the churning action of the heart and was removed by suction. The gloved finger was then introduced and circumscribed the outlines of the pericardial sac. No adhesions were felt. The incised edges of the pericardium were then sutured to the subcutaneous tissue, the wound left wide open, and dressings applied. The patient was placed in bed with her face down and kept in this position and on the left side as much of the time as was compatible with her comfort.

After the first forty-eight hours, the patient made a satisfactory and rapid convalescence. The pericardiotomy wound healed by granulation and was entirely closed in three weeks. Figures 4 and 5 show the condition of the chest and the scar one year after operation. The patient enjoys normal health and activity with no cardiac embarrassment, and presents no physical signs of residual cardiac damage.

Case II. Death. R. C., Jan. 3, 1928. A white male of twenty years with unimportant past and family histories suddenly developed chills, a temperature of 104°F., a severe headache, and pain and tenderness in all the muscles of his body. His throat was sore and his neck was stiff.

Examination on the following day revealed a red, angry, edematous throat with extensive membrane on the pharynx and both faucial tonsils and large tender cervical lymph nodes. A smear from the throat was negative for diphtheria bacilli. January 6, the third day after onset, he was taken with a rather sharp pain in the epigastrium and an inability to breathe lying down. The throat appeared to be less edematous and some membrane had been desquamated. The temperature was picketing from 101.5° to 105°F. There were several cutaneous petechial hemorrhages, considerable dyspnea, a definite cyanosis, and a marked arrhythmia with clear rapid heart sounds, but no rub or demonstrable enlarge-

ment of the heart. A blood culture taken at this time was reported later as a pure growth Streptococcus hemolyticus. The urine contained a trace of albumin and the white blood cell count was 12,000.

January 8, the dyspnea, cyanosis and arrhythmia had increased and the patient, sitting upright and laboring for breath, was obviously very critically ill. The area of cardiac dulness was considerably enlarged in all dimensions, notably at the base and to the right of the sternum. There was a positive Bamberger's sign and an absence of both the apex beat and heart sounds. The liver edge could be palpated 2 cm. below the costal margin. The pulse was rapid, irregular, and thready and could not be counted. Due to the constant refusal to have the patient removed to the hospital, *x*-ray examination was impossible. A pericardiocentesis was done in the sixth interspace, and 600 c.c. of blood-tinged fluid slowly removed. The patient experienced immediate and marked relief. The fluid cultured hemolytic streptococci. Four hours later the patient's general condition had improved sufficiently, it was felt, to withstand operative drainage. Consequently a pericardiotomy by the xiphocostal approach was done under local anesthesia and the wound was left wide open with a small catheter placed in the bottom of the posterior recess of the pericardial sac. Upon incising the pericardium there was a gush of considerable blood-tinged fluid and the surfaces of the pericardium and heart were markedly engorged and presented numerous minute petechial hemorrhages.

The pericardial cavity was irrigated every three hours with warm salt solution and for the next twenty hours the patient appeared to be progressing satisfactorily when he became delirious, developed opisthotonos and mild convulsive seizures. He died January 10, 1928, thirty-six hours after operation. Autopsy was refused.

## CASE HISTORIES COLLECTED FROM THE LITERATURE FROM MAY, 1927 TO MAY, 1931

Case 1.* Recovery. A female child aged four years and ten months was admitted to St. Bartholomew's Hospital October 7, 1928, with acute osteomyelitis of the left femur which was immediately drained. Four days later bronchopneumonia developed in both lungs and after eight days subsided by lysis, but a slight cyanosis, elevation of temperature and high pulse and respiratory rates persisted. The leucocyte count was 23,800.

November 1: The area of cardiac dulness extended 1 in. outside the midclavicular line on the left and ⅓ in. to the right of the right sternal border. The apex beat was not palpable and the heart sounds were not audible. The *x*-ray examination showed a heart shadow enormously enlarged in all directions, especially upwards, with the typical rounded appearance associated with pericardial effusion. On the following day, through an epigastric approach, the pericardial cavity was opened with the escape of 12 to 14 oz. of fluid. The wound was closed tightly but, upon receiving the bacteriological report on the following day, was reopened and a tube inserted through which irrigations were carried out.

A week later a left thoracotomy was done. The convalescence was further complicated by ascites and edema of the extremities but terminated in complete recovery.

Case 11.* Recovery. A Chinese soldier, aged nineteen, with a rifle bullet retained in the chest, presented four days after injury, blood-tinged sputum, increasing dyspnea and cyanosis, a temperature of 39.6°C., respirations, 36, and a pulse rate, 120. The heart was pushed markedly to the right and had a regular rhythm and no murmurs. The base of the left side of the chest was flat and the right dull with coarse râles throughout the entire chest and fine râles at the right base. The voice sounds were suppressed and tactile fremitus was absent at the left base and the percussion note hyper-resonant at the left apex. Chest plates localized the bullet at the level of the tenth rib in the midaxillary line. Upon a diagnosis of hemathorax or pyohemathorax, two unsuccessful attempts at thoracentesis were made.

Then 100 c.c. of yellow turbid fluid were removed by pericardiocentesis. Two days later this procedure was repeated and both the smear and culture of the fluid demonstrated hemolytic streptococci.

On the following day a pericardiotomy was done through an exposure gained by resecting the cartilage of the sixth rib. No drainage tubes were inserted but the pericardial sac was

* Beattie, W. J. H. M. *St. Bartholomew's Hospital* J.; Thomas, T. M. *Arch. Dis. Childhood*, 4: 67–75, 1929.

* Loucks, H. H. *Arch. Surg.*, 18: 852–867, 1929.

frequently irrigated with a solution of chlorinated soda.

It became increasingly evident that drainage was inadequate and that there was a walled-off abscess in the posterior pericardial cul-de-sac, so thirteen days after the anterior drainage a posterior pericardiotomy was done through an empyema drainage sinus previously established in the posterior axillary line with resection of a section of the eighth rib. This was done with the evacuation of 800 c.c. of pus. The patient was immediately relieved and made a slow but constantly progressive convalescence and one year later was able to do ordinary labor.

Case III. Death, *idem*. A man, aged thirty, with a diagnosis of pulmonary tuberculosis gave a history of abscesses of the neck and right inguinal region three and two months respectively before the onset of symptoms of a pericarditis. The patient complained of pain over the precordium and progressive weakness and dyspnea.

Examination revealed bulging of the precordium from the second to the sixth interspace. The area of cardiac dulness extended from 3 cm. beyond the left midclavicular line to 4 cm. beyond the right midclavicular line. The temperature was 102°F., the pulse was rapid but the heart sounds could be clearly heard. The *x*-ray examination showed the heart shadow to be markedly increased in all diameters with displacement of the mediastinum to the right. No tubercle bacilli were found in the sputum and the white blood cells counted 18,000.

A pericardiocentesis was done with the escape of 20 c.c. of pus. This contained no tubercle bacilli but cultured Staphylococcus aureus.

The costal cartilage of the fifth rib was resected and the pericardium exposed and incised. It was so densely adherent to the heart muscle that an attempt to establish drainage at this site was abandoned and the pericardial sac drained in the posterior axillary line by perforating the lung which was adherent to both the pericardium and chest wall.

The symptoms referable to the pericarditis promptly subsided but the inguinal sinus continued to drain and there developed a destructive lesion with wedging of the first and second lumbar vertebrae with a perispinal abscess pointing posteriorly. This was incised and a diagnosis of actinomycosis established. The patient died soon afterward.

Case IV.* Recovery. A white male of twenty-seven years was seen April 24, six weeks after the onset of pneumonia, and presented evidence of fluid in the pericardial and both pleural cavities. There was marked dyspnea, cyanosis, a rapid feeble pulse, a septic temperature, painful respiration, muffled heart sounds, and a history of a pericardial rub. *X*-ray observation showed enlargement of the heart to both sides, fluid in the left chest and encysted fluid in the right pleural cavity. The leucocyte count numbered 11,000.

On April 25 the right empyema cavity was drained and pneumococcus, Type I, was cultured from the pus. On April 26 the left pleural cavity was aspirated of 500 c.c. of clear fluid. On April 28 pericardiotomy, with resection of the sixth costal cartilage and insertion of a drainage tube, was followed by irrigations with saline and Dakin's solutions. Type I pneumococcus was found in the pus from the pericardial cavity.

The patient had a stormy but satisfactory convalescence and subsequent examination showed no evidence of residual cardiac damage.

Case V.† Death. A white male child of one year was admitted to the hospital November 14 with a history of good health until the onset of pneumonia four weeks previously. On admission the temperature was 99.2°F., the pulse 140, respirations 52, and the child was very dyspneic and acutely ill. There was evidence of consolidation of the lower lobe of the left lung and râles were heard over both lungs. The liver was palpable 2 cm. below the costal arch. The *x*-ray studies of the heart showed the characteristically enlarged shadow of a pericardial effusion.

November 23, 25 c.c. of pus were aspirated from the pericardial cavity and from it the influenza bacillus was identified. Two days later the fifth costal cartilage was resected and drainage established. A rubber tissue drain was inserted and irrigation with saline instituted. On the following day the lung signs increased and the patient died thirty-six hours after operation.

Case VI. Recovery. *Idem*. A white female child of 3½ years entered the hospital June 14 with a history of a blow on the head followed by temperature for two weeks varying from

* Harrington, S. W. *Surg. Clin. North America*, 9: 133–138, 1929.

† Peterson, E. W. *Arch. Surg.*, 16: 366–379, 1928.

100°F. to 104°F. The pulse was 144, respirations 60, the heart sounds distant; and a greatly enlarged heart shadow was demonstrated by percussion and *x*-ray examination. Five days later the pericardial cavity was aspirated and the pus removed contained Staphylococcus albus. June 25, the sixth costal cartilage was resected and the pericardium opened with the escape of 750 c.c. of thick pus. The pericardium was sutured to the chest wall and no drainage material inserted but the patient was turned on her face for thirty minutes every three hours to accomplish gravity drainage. The convalescence was rapid and uneventful and there was no evidence of residual functional cardiac damage.

Case vii. Recovery. *Idem*, Feb., 1928. A white male child aged fourteen years was critically ill with lobar pneumonia of the left lower lobe for two weeks. By March 10, signs and *x*-ray evidence of an effusion of the left chest and of a large pericardial exudate were definite. The temperature was 105.6°F., respirations 40, pulse 140 and dyspnea was marked. Repeated thoracenteses and later a thoracotomy were done to drain the left pleural cavity.

On March 23 the pericardium was aspirated of 1600 c.c. of pus (pneumococcus Type II). Two days later the sixth and seventh left costal cartilages were removed and the pericardial cavity opened. The pericardium was sutured to the intercostal fascia and no irrigation or drainage material was used. As in the preceding case, postural drainage was employed. During convalescence there was some edema of the legs and myocardial insufficiency was feared, but this disappeared after the evacuation of reaccumulated pus in the previously drained pleural cavity. Further convalescence was then rapid and uneventful.

Case viii.* Recovery. (Reported by Williamson but not by Alexander.) A case of purulent pericarditis following empyema, cured by closed catheter drainage accomplished by intermittent suction and no irrigation. Pneumococcus was the infecting microorganism.

Cases ix and x. Deaths. *Idem*. Two cases of Streptococcus septicemia involving the pericardium. Both were treated by suction through a closed drainage catheter as in Case viii.

Case xi. Death. *Idem*. A case with undetermined bacteriology was treated by the removal of a costal cartilage, the insertion of two tubes and irrigations. The patient died of septicemia.

Case xii.* Death. Suppurative pericarditis developed as a complication of scarlet fever and drainage was established by the resection of the left fourth and fifth costal cartilages. Tissue drains were led into the pericardial cavity and the same was irrigated. Death was caused by a continuous uncontrollable hemorrhage.

Case xiii. Death. *Idem*. This case received the same treatment described in Case xii. At autopsy an apical tuberculous cavity was found to communicate with the pericardial sac through a sinus.

Case xiv.† Death. A boy of eighteen was stabbed over the sternum with a knife. There was marked shortness of breath and *x*-ray examination revealed 1½ in. of the knife blade imbedded in the sternum. In the course of its removal a suppurative process of the pericardial sac was discovered. Drainage was established but the patient died from recurring hemorrhages despite repeated transfusions.

Cases xv and xvi.‡ Recoveries. No discussion was given of these cases.

Case xvii. Death. *Idem*. A child with empyema developed a purulent pericarditis, was operated upon and died.

Case xviii. Death. *Idem*. A case with the pericardium secondarily infected with actinomycosis by a needle.

Case xix.§ Recovery. The patient was a boy, four years old. The onset of the disease was gradual, with chilliness for three or four days and little languor and fever at times. One night he complained of pain in the throat, and immediately began to have difficulty in breathing. Notwithstanding the negative findings of the throat, he was given an injection of diphtheria antitoxin. He became progressively worse and complained of a choking sensation.

On examination there was a marked pleural effusion on the left side. The pulse was 160,

* Whittemore, W. *Arch. Surg.* (discussion), 16: 366–379, 1928.

* Miller, R. T. *Arch. Surg.* (discussion), 16: 366–379, 1928.

† Andrus, D. W. *Arch. Surg.* (discussion), 16: 366–379, 1928.

‡ Lilienthal, H. *Arch. Surg.* (discussion), 16: 366–379, 1928.

§ Zeno, A. *Bol. y. Trab. de la Soc. de Cir. de Buenes Aires*, 11: 452–456, 1927.

small but regular. There was no precordial pulsation, the apex beat could not be localized, and the precordium was bulging. The cardiac dulness was enlarged, extending down to Traube's space on the left, far beyond the normal limit on the right and down to the liver dulness. The heart sounds were very faint. The temperature was 102.2°F. Puncture of the right pleural cavity yielded creamy pus, which was sterile on direct examination and on culture. Three days later, 150 c.c. of pus were evacuated from the same side by aspiration.

Two days later, under local anesthesia, a portion of the sixth cartilage was resected, the internal mammary artery ligated, and the pericardial sac was opened. A large amount of liquid pus escaped and a drainage tube was placed in the cavity. The pleura was punctured and emptied from time to time and the patient recovered in a month.

When he returned to the clinic four years later, the cardiac measurements were normal, and the *x*-rays showed normal heart action. "No traces of this grave disease remained."

Case xx.* Recovery. The patient was a woman twenty-three years old. She entered the hospital on December 10, 1926, with a thrombophlebitis of the left jugular vein following an attack of influenzal otitis which had been present for fifteen days. Her temperature was 104°F.

A left mastoidectomy with resection of the thrombosed portion of the jugular vein was done. A blood culture was made on the same day and was negative. The immediate postoperative result was excellent.

Her temperature rose again on the fourth day and she complained of abdominal pains. It was thought at first that she had appendicitis or salpingitis. However, she soon had dyspnea with signs of a pleural effusion at the right base. An exploratory puncture was negative.

On account of continuous dyspnea she was obliged to remain seated in her bed. The area of cardiac dulness was increased and the heart sounds were weak and distant. A radioscopic examination showed that the cardiac shadow was enlarged and that there were no pulsations of the pericardium.

A puncture by the epigastric route was done on December 29 and 240 c.c. of greenish pus were obtained. This pus contained pneumococci. She was relieved by this procedure and improved for forty-nine hours.

On the morning of December 31, she attempted to lie down and was suddenly seized with cyanosis and dyspnea and a weak and rapid pulse. There were pulsations of the jugular veins. A parasternal puncture only permitted about 30 gm. of pus to be removed and the symptoms remained unchanged. Two subsequent aspirations were done with only temporary relief. Her face was livid, her pulse was thready, her body was covered with cold perspiration and syncope was imminent, on January 8.

With the patient in a semi-reclining position, a vertical incision was made at the level of the tip of the xiphoid appendix under local anesthesia. The appendix was resected, the pericardium was opened, and from 300 to 400 c.c. of pus escaped. A strip of folded rubber sheeting was introduced into the pericardial cavity for drainage.

The pain and dyspnea were relieved but her condition still remained critical during the following days. However, she made a complete recovery and left the hospital on April 29.

She was again seen in June and was in excellent condition. A clinical and radiological examination of the lungs and heart did not show any trace of the pericardial inflammation.

Case xxi.* Recovery. The patient was injured in the early part of January by a bullet from a revolver, entering the chest at the left sternal margin. She was brought to the hospital in a pulseless condition and in shock. The patient recuperated after several days, but distinct signs of an acute pericarditis manifested themselves. After the patient had recuperated, roentgenological examination was made. The bullet was situated directly above the outline of the stomach upon the diaphragm, the shadow of the heart was enlarged to the left and showed the pouch-shaped wine-bottle form characteristic of pericarditis. The temperature at that time was subfebrile. The roentgenologist concluded from the findings that the projectile was situated within the pericardium. On January 31, the thorax was opened by means of a costoxiphoidal incision (according to Rehn) and the pericardium was

* Ramond, L. *Presse Méd.*, 36: 763–64, 1928; Ramond, L., and Weill-Spire, R. *Bull. et mem. Soc. med. d'hop. de Par.*, 51: 1163–1166, 1927.

* Albrecht, P. *Wien. med. Wchnschr.*, 77: 390, 1927.

incised. It was covered with a thick yellowish-red layer of fibrin. Upon opening this membrane, about 250–300 c.c. of a turbid serous-hemorrhagic fluid escaped. The projectile at the outer side of the left ventricle was removed with a pair of forceps. The wound was drained and the drainage was shut off towards the outside by means of a sterile rubber glove, in order to prevent the entrance of air. The patient is now permanently free from symptoms.

Case xxii. Recovery. *Idem.* The patient had been injured by a pistol shot in the right thoracic cavity in October, 1919. The projectile was situated in the mediastinum close to the median line in the pericardial-hepatic angle. It was not removed. The existing hematothorax caused no anxiety. The temperature soon was normal, so that the patient was discharged after three weeks, pursuant to his own wish. After two weeks he again reported to the hospital. Symptoms of a pericarditis were found. At operation the pericardium was filled tautly with a serous-hemorrhagic exudate. A cure was effected in a short time and the patient performs hard labor, occasionally experiencing lancinating pains in the cardiac region. Two years later the findings were normal, including the electrocardiogram.

Case xxiii.* Death. The patient was a boy of four years, who was attacked by angina due to an infection with Streptococcus hemolyticus. On the seventh day after recovery, the temperature rose again and he appeared to suffer from purulent pericarditis. Treatment consisted in the performance of pericardiotomy, after which the greatly distended pericardium rapidly collapsed. After a temporary recovery, death from sepsis occurred four weeks after the operation. The pericardium was not thickened and on its incision, a large quantity (300 c.c.) of a thin greenish-yellow flocculent pus escaped. A rubber drain was placed in the opening. The pus yielded a pure culture of streptococcus, presumably the pathogenic agent also of the throat infection. At autopsy it was shown that the thickened pericardial layers were at no point adherent to each other or agglutinated. The microscopical findings showed a purulent infiltrate of the lungs and also of the superficial layer of the pericardium.

* Van der Hoff, H. L. M. *Nederlandsch Tijdschrift v. Geneeskunde*, 74: 1480–1482 (March 22) 1930.

Case xxiv.* Recovery. A man, thirty years old, was brought to the hospital June 26, 1929. He had a high fever, difficult respiration and a painful cough. Examination showed signs of a frank pneumonia of the left lower lobe. There was dulness, increased fremitus and fine crepitant râles. On the sixth day he had a violent delirium followed by hypothermia and an apparent crisis. On July 3 his temperature rose to 102.2°F. and at the same time he had severe dyspnea with a rapid weak pulse.

On July 6 he could not lie down without suffocating. Respiration was rapid, difficult and painful. His face was pale and covered with perspiration. He had severe pain which he localized in the precordial region and epigastrium; also a very slight cough with no expectoration. His lips were blue and congestion of the venous circulation was manifested by the constant distention of the jugular veins.

The dulness at the left base still remained. The precordial dulness was much greater than normal. It extended beyond its usual limits and was continuous below with the hepatic dulness. The liver was large and painful and extended beyond the false ribs. The apex beat could not be perceived. Auscultation showed that the heart sounds were weak and distant. The pulse was 140 and seemed to be intermittent. There were cardiac contractions which were not perceived at the wrist.

A radiographic examination showed an enormous pericardial effusion. It was globular in shape and did not show any pulsations.

On July 10 he was breathless, covered with perspiration; had practically no pulse and seemed to be dying. A puncture made in the fifth left intercostal space near the left edge of the sternum yielded 500 c.c. of a cloudy serofibrinous fluid, and the patient was relieved immediately. The dyspnea decreased, the venous stasis diminished and the pulse became countable. A bacteriological examination of the fluid showed a pure growth of pneumococcus.

On July 12 pericardiotomy was performed under local anesthesia. The cartilages of the fifth and sixth ribs were resected and a large drain was introduced as far as the apex of the heart. The pericardial cavity was irrigated with warm salt solution and a large amount of false membrane was evacuated. The patient

* Grimaut, L., *Rev. med. d'est., Par.*, 58: 261–271 (April 1) 1930.

was immediately relieved and his condition improved rapidly. Convalescence was complicated by a long persistent tachycardia and a transient edema of the lower extremities.

Case xxv.* Death. A woman entered the hospital September 13, 1926, with fever, cough, cyanosis, vomiting and dyspnea. The last menstruation was May 15 but on August 6 the patient began to bleed. Three days later she was delivered of a four months' pregnancy and was curetted. Four days after this she had a chill and was again curetted. The next morning she awakened with a severe pain at her heart and had difficulty in breathing. She became gradually worse, had fever and began to vomit.

The patient was cyanotic and breathed rapidly and laboriously. The pharynx was red and the breath foul. There was bronchial breathing, increased vocal fremitus, dulness in the lower lobe of the left lung, and the cardiac dulness was increased on both sides. The heart sounds were muffled but the apex beat was apparently within normal limits.

September 14, the *x*-ray revealed an enormously widened pericardial shadow. Under local anesthesia the patient was needled three times for pericardial fluid and nothing but blood obtained. The next afternoon she appeared moribund, had an imperceptible pulse, a cold, wet, blue body, labored respiration and was unconscious. Emergency paracentesis was resorted to. A drop of blood appeared, then 115 c.c. of thick yellow pus. As this was removed the patient's color and senses returned. Her pulse was again obtainable and she rested decidedly more easily. By *x*-ray there was no diminution in the size of the pericardial shadow. On the following morning pericardiotomy was done under gas anesthesia. The heart was found adherent to its sac, walling off a small empty pocket posteriorly. A rubber drain was left at the edge of the pericardial incision.

The patient left the operating room in fair condition but at 5 p.m. her pulse became weak and her respiration difficult. She died two hours later.

The autopsy showed uterine involution; suppurative pericarditis (streptococcus) with adhesions and dorsal abscess formation; suppurative mediastinitis pointing beneath the xyphoid; multiple infarcts of the right lung and kidneys; serofibrinous pleuritis (right); cloudy swelling of the heart, kidneys, liver and spleen.

Case xxvi.* Death. A female child of six and a half years was admitted June, 1925 with pain in the epigastrium, dyspnea, and fever. The onset seven weeks previously with an upper respiratory infection and otitis media was followed by pneumonia. On admission the pulse was 160, respirations 75, and the child was pale, cyanotic, and very restless and dyspneic.

Examination revealed dilated superficial veins, shallow labored breathing and a flat note over the entire chest. There were fine râles over the left upper and tubular breathing in the right lower portions of the chest. The left border of the heart extended to the posterior axillary line, the right to the right anterior axillary line. The apex beat was not visible or palpable and the cardiac sounds were muffled. The liver was down 5 fingers.

A diagnosis of pericarditis with effusion, interlobar empyema, and pneumonia was made. The urine was negative, the red blood cells numbered 3½ million and the leucocytes 24,000.

Radiographic examination showed the heart practically filling the chest below the fourth rib and extending to the second rib posteriorly. There was increased density throughout the right lung. Reexamination after removal of 60 c.c. of fluid from the left chest with air replacement outlined a fluid level in the pericardial sac.

The child's condition became very critical and a pericardiotomy was done by the method of closed catheter drainage. The pericardial cavity was irrigated with saline and later with Dakin's solution.

For a few days there was a rapid improvement but this was terminated by mastoiditis, mastoidectomy and streptococcus septicemia. A fatal outcome resulted and necropsy was refused.

Both the pericardial exudate and the blood culture grew Streptococcus hemolyticus.

Case xxvii. Recovery. *Idem.* A male negro, aged thirty-one years, was admitted January, 1926, with a temperature of 103.4°F., a pulse of 100, and respirations 44. The onset two days previously was marked by pain in the chest, weakness, and a choking sensation.

* Welch, H. J., and Welch, H. S. *J. Missouri M. A.*, 25: 65–67,

* Harloe, R. F. *Long Island M. J.*, 22: 633–640, 1928.

There were signs of consolidation at the base of the right lung.

On January 20 a pericardial friction rub was heard and three days later definite signs of a pericardial effusion developed. The cardiac borders reached on the left 12 cm. and on the right 6 cm. from the midsternum. This was corroborated by *x*-ray examination and the shadow was characteristically flask-shaped. There was increased density of the lower lobe of the right lung.

On January 30 pericardiocentesis yielded 130 c.c. of pus which cultured Streptococcus hemolyticus. Two days later a closed pericardiotomy was done and the pericardial cavity was irrigated with salt solution.

Convalescence was complicated by a phlebitis of the right subclavian vein, but slowly became complete with no evidence of residual cardiac damage.

Case xxviii.* Death. A male, seventeen years of age with onset of pain in the lower left chest had a non-productive cough, temperature 102°F., and signs of lobar pneumonia of the left chest. Ten days later signs of fluid developed and the left pleural cavity was drained by the closed method. Twenty-one days after onset, chills, dyspnea, cyanosis, and pain over the liver (enlarged) developed. The heart sounds were distant and the area of cardiac dulness was enlarged. Edema of the legs and dilatation of the superficial veins of the thorax followed, and the roentgenograms were typical.

Pericardial aspiration brought considerable relief. The fluid contained pneumococci. On the following day pericardiotomy was done by resection of the costal cartilage of the sixth rib. The pericardium was exposed and perforated with a gall bladder trochar, with the escape of 600 c.c. of pus. A catheter was fixed within the pericardial cavity with a purse-string suture and immersed in a vessel of antiseptic solution. For four days there was marked improvement and then overwhelming sepsis caused death seven days after operation.

Case xxix.† Death. A married woman of twenty years, who for two weeks had had bronchopneumonia of the apex and left lower lobe, developed marked and extensive dulness over the precordium. The heart sounds were feeble and distant and seemed to become more so on inspiration, and the pulse was 106. An *x*-ray examination showed a large water-bottle pericardial shadow; also a shadow in the upper two-thirds of left lower lobe. The patient had markedly embarrassed breathing and was obviously critically sick. The white blood count was 20,800, polymorphonuclears 87 per cent.

October 10, a left pericardial puncture in the fourth interspace yielded 480 c.c. of turbid fluid and on October 24, a pericardiotomy was done with the evacuation of 620 c.c. of thick purulent fluid. On dissecting back the left breast, an abscess was found beneath the fascia, a result of the puncture made fourteen days previously.

On December 6 the patient made her exodus with the final diagnosis: (1) Pneumonia, (2) suppurative pericarditis, (3) chronic passive congestion of liver, and other viscera.

Case xxx.* Recovery. A girl of eight years developed purulent pericarditis (streptococcus) following erysipelas. Drainage was established through the epigastric route and the patient rapidly recovered. One month after operation she was again enjoying normal health and the physical and *x*-ray examinations indicated no evidence of pericardial adhesions.

Case xxxi. Death. *Idem*, 1929. A boy, fourteen years of age, had been treated by repeated aspiration of serosanguineous fluid from the pericardial cavity without benefit. Tube drainage was instituted through a Larrey approach and the patient showed considerable improvement with diminution of the cyanosis and dyspnea for a few hours. However, collapse and death ensued thirty-six hours after operation.

Case xxxii. Death, *Idem*, 1930. A child aged ten years developed a purulent pericarditis (pneumococcus) following pneumonia of the left lung. The temperature ranged from 39° to 40°C. and asphyxia seemed imminent. Clear fluid was aspirated from the left pleural cavity and a pericardiotomy was done through the epigastric route. The temperature persisted, clear fluid was again withdrawn from the left pleural cavity and signs of pneumonic involvement were found in the right lung. On the fifth day after operation death occurred from a copious secondary hemorrhage from the wound. Postmortem examination established the source of hemorrhage from the

* Bowers. *Arch. Surg.*, 19: 301–308, 1929.

† Brenizer, A. G. *Southern M. & S. J.*, 91: 468–471.

* Févre, M. *J. de Chir.*, 35: 656–77, 1927.

internal mammary vein and demonstrated complete drainage of the pericardial cavity.

This collection and analysis does not include 3 cases which have been reported, for the reason that they were not treated by pericardiotomy, but by aspiration only, with complete recovery in two instances.

Capogrossi described a case of pneumococcus pericarditis following pneumonia, which was treated by pericardiocentesis with a rapidly fatal result.

Dujol's patient completely recovered after a single evacuation of the pericardial cavity by needle aspiration. His patient was a woman, aged twenty-five years, with a staphylococcus septicemia following an abortion. After removing 200 c.c. of purulent fluid, the patient was promptly relieved and showed no further tendency to reaccumulate an effusion.

A similar experience was reported by Aritzenius. A perfectly healthy girl of eleven years fell and sustained an injury to her chest. On the following day, she developed a fever and a few days later a delirium and evidence of bronchial pneumonia. In the second week an empyema of the left pleural cavity was drained by rib resection. The temperature did not subside, and the area of cardiac dulness remained large and progressively extended to the right. Consequently, a pericardial puncture was done and seropurulent fluid was evacuated. Staphylococcus aureus was demonstrated in this exudate. Without further treatment directed to the pericardium, the patient made a complete recovery.

## SUMMARY AND CONCLUSIONS

1. Purulent pericarditis is essentially a complication of other diseases and is met principally in childhood and early adult life.

2. That its presence has so frequently been unsuspected, until disclosed by postmortem section, would indicate a lack of due consideration of this complication.

3. Quite consistently characteristic clinical pictures and *x*-ray findings have been observed in all reported cases. Pericardiocentesis or exploration readily establishes the diagnosis.

4. A consideration of the relative mortality rates of 45 per cent in cases receiving surgical drainage and approaching 100 per cent in undrained cases presents no question for decision as regards treatment.

5. Insufficient data have been accumulated to make a comparative evaluation of the various methods of drainage. The advantages of the air-tight closed operation have been demonstrated experimentally but unfortunately it is a rather blind procedure and does not permit exploration. The use of drainage material and irrigations in open drainage, may be guided by the nature of the exudate and offending micro-organisms but it would seem highly desirable to avoid placing any foreign body within the pericardium. Reliance upon the expulsive action of the constant motion of the heart and upon postural drainage has proved as effective as any other method in the small group of cases so treated.

Table III

TYPES OF DRAINAGE

| | Recoveries | Deaths | Total |
|---|---|---|---|
| 1. Open drainage with tube or wick (rubber, gauze, etc.) | 66 | 46 | 112 |
| 2. Open drainage with no tube or wick | 9 | 3 | 12 |
| 3. Closed catheter drainage | 2 | 4 | 6 |
| 4. Not stated | | | 41 |
| 5. (Open postural drainage) | (4) | (0) | (4) |
| | 77 | 53 | 171 |

6. The compiled reports contain surprisingly few cases with symptomatic evidence of resultant adhesive pericarditis or other heart damage.

The frequent multiplicity of lesions and indefinite early histories of many records made identification of the primary focus in many instances somewhat uncertain.

The bacteriological classification was based upon and includes the reports of the bacteriology of blood cultures or of the pericardial exudate removed at operation, pericardiocentesis, or post mortem.

[For References see p. 65.]

# A NEW MODIFICATION FOR THE INJECTION METHOD OF ARTERIOGRAPHY (INJECTION IN REFLUENCE)*

PROF. DR. MAKOTO SAITO AND DR. K. KAMIKAWA

NAGOYA, JAPAN

IN arteriography there are two different methods:

1. Percutaneous injection.

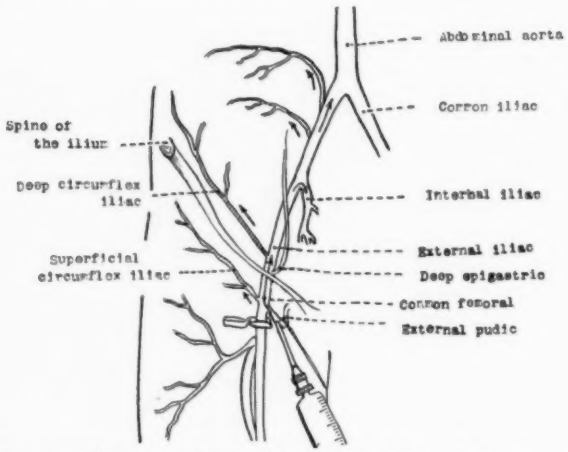


FIG. 1. Diagram of injection method in refluence. SI, Spine of ilium. DCI, Deep circumflex iliac artery. SCI, Superficial circumflex iliac artery. AA, Abdominal aorta. CI, Common iliac artery. II, Internal iliac artery. EI, External iliac artery. DE, Deep epigastric artery. CF, Common femoral artery. EP, External pudic artery.

2. Incision method (surgical method).

Of these two, the percutaneous injection has been carried on in human beings since the days of the discovery of salvarsan. Knauer, Benedik and others used this method for the treatment of brain syphilis by the injection of salvarsan solution into the internal carotid artery. And Moniz first tried this method for arterial encephalography. But in this percutaneous injection the contrast media is injected in diluted form into the blood vessel and the result is not always good. Moreover the opaque substance must be used in a strong concentration. For example, Dos Santos has put a hundred per cent solution of sodium iodide to good use in aortography.

In the incision method, on the contrary, arteries are exposed and the injection carried on under direct vision. Therefore, we can utilize with the incision method deep arteries which are inaccessible for percutaneous injection, and here the incision method is superior to the percutaneous method in the certainty and excellence of the result.

We may further classify the incision method into:

(a) Puncture of the trunk of the artery.

(b) Puncture of a small branch of the arterial trunk (our method).

*a. Puncture of the Trunk of the Artery.* As usually known, an arterial clamp is applied on the artery, the trunk of the artery is punctured, and the injection is begun. This is called "arteriography after the closure of the blood stream" (*arteriographie en circulation bloquée, Arteriographie in abgesperrter Blutzirkulation*).

As in Mauculaire's case, with puncture of the arterial trunk we are not only compelled by greater bleeding sometimes to ligate the artery, but we are really prevented from using it for patients with arteriosclerosis.

*b. Puncture of a Small Branch of the Arterial Trunk.* To remedy these deficiencies, we inject a branch of the artery. As we have already written, in arterial encephalography we use the superior thyroid artery. In arteriography of the extremities, puncture of the following branches is made: the superior or inferior ulnar collateral artery in the arm; the external pudendal artery in the thigh; the lateral or medial superior artery of the knee in the fossa poplitea.

From the standpoint of direction of stream of the opaque substance injected, we have decided to name this above-stated method "arteriography in current" (*l'ar-*

* Submitted for publication July 17, 1931.

*teriographie par injection descendant, Arteriographie durch absteigende Füllung*). In this injection "in current," peripheral arteries from the punctured point and both deep and superficial venous systems are included in the radiographic studies. But we cannot possibly visualize the arteries of the body trunk such as axillary artery, subclavian artery, arteries in the pelvic cavity, etc. except by Dos Santos's method of aortography.

Therefore we have originated a new method of injection, as follows: The artery is exposed and the arterial clamp applied; then a certain amount of the opaque substance is injected at a point proximal to the arterial clamp, in refluence of the blood stream. This is called "arteriography in refluence" (*l'arteriographie par injection ascendant, Arteriographie durch aufsteigende Füllung*).

The practical application of this new method is illustrated by the following brief reports and plates.

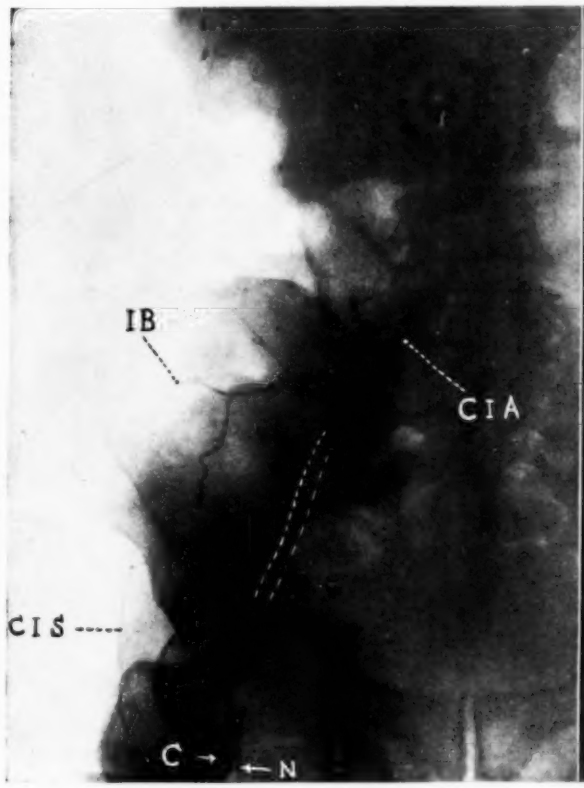


Fig. 2. Arteriogram of arteries in pelvic cavity, obtained after injection of l'ombre in refluence. C, Clamp on femoral artery. N, Needle. CIS, Arteria circumflexa ilium superficialis. IB, Iliac branch of iliolumbar artery. CIA, Common iliac artery.

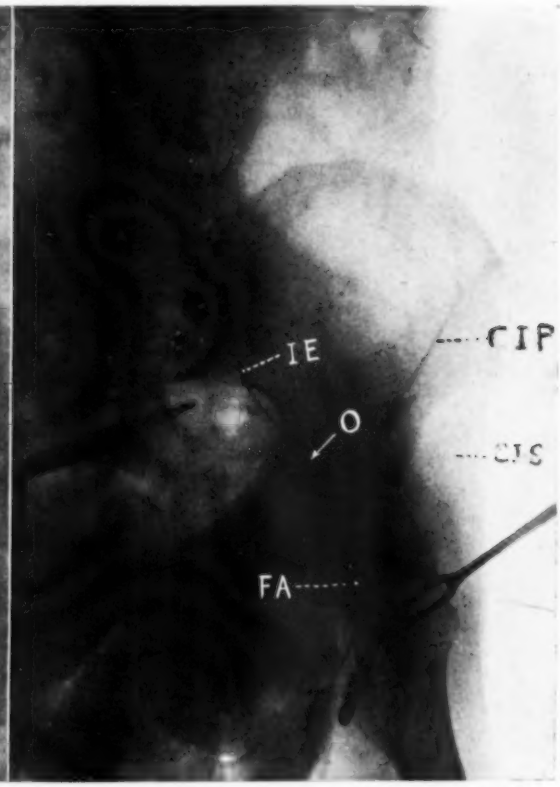


Fig. 3. Arteriogram of pelvic cavity obtained with injection of l'ombre in refluence. FA, Femoral artery. O, Obstruction of external iliac artery. IE, Inferior epigastric artery. CIP, Deep circumflex iliac artery. CIS, Superficial circumflex iliac artery. Both inferior epigastric and deep circumflex iliac arteries are used as collateral blood circulation.

Case 1. T. N., aged sixty-two, male. Diagnosis: Buerger's disease and arteriosclerosis.

Thirty years ago he worked in a district of severe cold. Since then he has felt a coolness in his lower extremities. Last year a cyanosis, then an ulcer of the right hallux, occurred. On admission to the hospital, May 19, 1930, it was noted that the left lower extremity showed marked swelling below the knee, colored violet-black in some places, with an ulcer in the hallux. One could not feel the pulsation of the femoral, popliteal and anterior tibial artery. On the right side there was no ulcer but we felt the thigh cool. Pulsation of the femoral artery could be felt directly below Poupart's band. There was no pulsation of the popliteal or of the anterior tibial artery. In this case "arteriography in current" was

performed by injection of the external pudendal artery after closure of the femoral artery. This roentgenogram showed that in the right

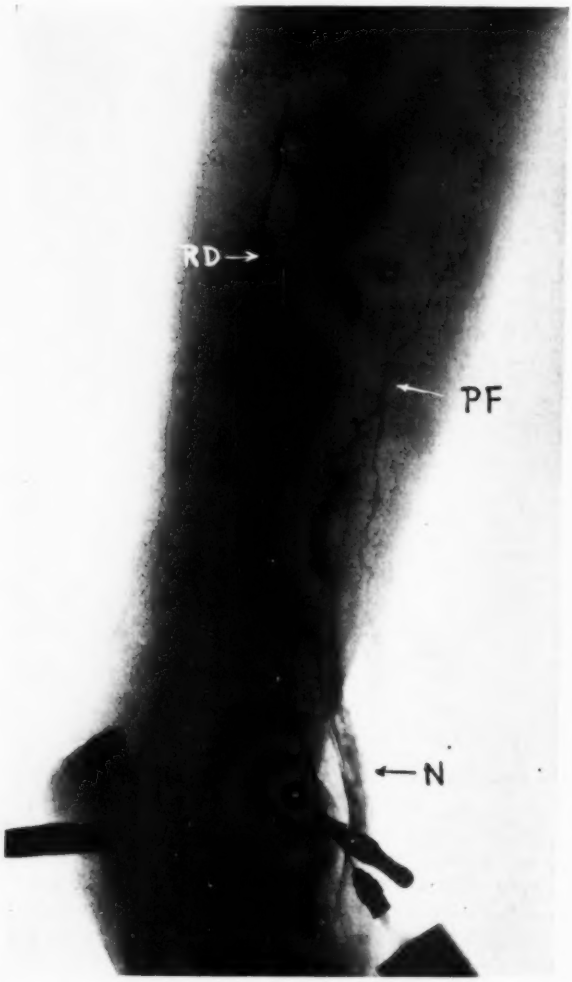


Fig. 4. Arteriogram of collateral circulation in case of obstruction of femoral artery. RD, Descending branch of circumflex lateral femoral artery. PF, Deep femoral artery. N, Common peroneal nerve (neurographic figure). Descending branch of circumflex lateral femoral and deep femoral arteries are used as collateral circulations.

side the femoral artery was obliterated and the ramus descendens of the deep femoral artery dilated and coiled then flowed into the popliteal artery. In the left side the femoral and popliteal arteries were not obliterated, but the lumen of these arteries was very irregular and thin.

We used in this case "arteriography in refluence," our new method; using on both sides l'ombre, a fine iodized oil emulsion, into the femoral artery "in refluence" to the blood stream after closure of the femoral artery (Fig. 1). This arteriogram showed that on the right side (Fig. 2) the opaque substance filled the common iliac artery up to the abdominal aorta (A. hypogastricum, A. iliolumbalis, A. epigastrica inferior and A. circumflexa ilium profunda, etc.) while on the left side it is noted that, as in Figure 3, the external iliac artery was obliterated, and as a collateral circulation the last intercostal artery and internal mammary artery ran into the femoral artery through A. circumflexa ilium profunda and A. epigastrica inferior. In Figure 4, which was taken by injection in refluence through the lateral superior artery of the knee in the right poplitea, the following collateral circulations are seen: PF is the collateral circulation from A. femoris profunda, RD is ramus descendens of A. circumflexa femoris lateralis. N shows the common peroneal nerve which was visualized in the film by neurography. Neurography is carried out by injection of l'ombre perineurally and intraneurally. There are no functional and pathological changes of the injected nerve.

Case II. T. Y., aged forty-eight, female. Diagnosis: Aneurysm of axillary and subclavian artery.

For ten months, she has been suffering from neuralgic pain in the right upper extremity. For four months, a swelling of hen's egg size has been present in the right axilla and it did not disappear in spite of all antiluetic therapy. On admission into the hospital on Nov. 15, 1930, it was noted that the tumor in the right axilla was fist-sized and pulsating. The dilated veins on the skin overlying the tumor are seen. The right radial artery was very feeble; in the outer side of the upper arm and on the dorsum of the hand there was hypalgesia. After temporary resection of the right clavicle, double ligatures of the artery were performed, one proximal and the other distal to the tumor. The roentgenogram which was taken after operation by injection into the tumor cavity (Fig. 5) showed that the inner wall of the tumor was irregular and the cavity of it was

small in comparison with the tumor itself, owing to the blood clot in it. In spite of the ligature of the main artery to the upper extremity we could note nothing important and there were no noticeable symptoms caused by disturbance of the arterial circulation.

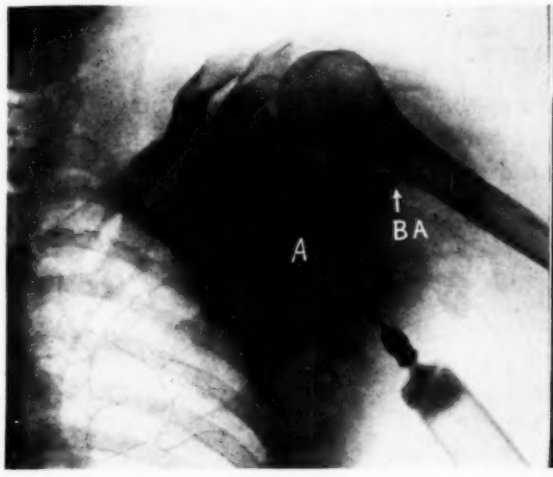


Fig. 5. Aneurysmogram by puncture of aneurysmal cavity after ligation of artery. A, Cavity of aneurysm. BA, Brachial artery, ligated.

The following broad fact explains this. In the brachial artery exposed in the elbow, arteriography by injection in refluence was performed. The roentgenogram, as seen in Figure 6, showed that the brachial artery disappeared at the axilla but at that point a fairly thick artery ran up to the shoulder. This artery is the A. circumflexa humeri posterior which as a collateral circulation anastomosed to A. transversa scapulae and A. transversa colli. Through these, the upper extremity has been nourished.

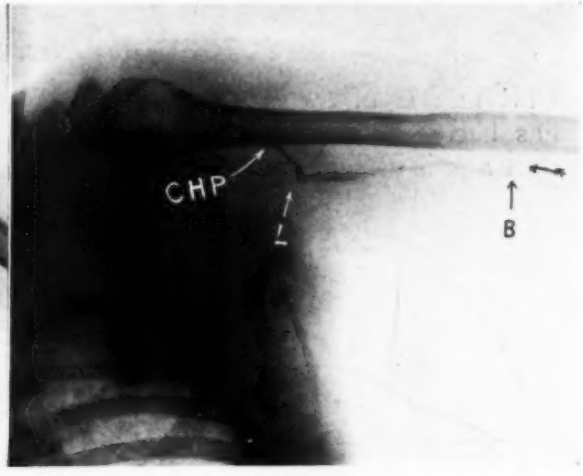


Fig. 6. Collateral circulation in patient with aneurysm. B, Brachial artery. L, Ligation of brachial artery. CHP, Arteria circumflexa humeri profunda, which was used as collateral blood circulation. Arrow indicates direction of injection of l'ombre.

## CONCLUSION

We have demonstrated a new method of arteriography by "injection in refluence." By this method we are able to visualize the arteries in the pelvic cavity, obstruction of the external iliac artery, and the collateral circulation in a patient with a large aneurysm of the subclavian artery. This injection method "in refluence" will open the way for practical clinical visualization of the arteries of the trunk of the body, such as the subclavian artery, and the arteries in the pelvic cavity.

# A METHOD OF VENTRICULAR PUNCTURE*

ALBERT S. CRAWFORD, M.D.

DETROIT, MICH.

PUNCTURE of the lateral ventricles has become a well-recognized procedure and is indicated under the following conditions: (1) as an aid in localizing intracranial lesions (ventriculography or ventricular estimation of Dandy); (2) as a safer means of obtaining diagnostic spinal fluid when there is likely to be a blockage in the circulation between the third and fourth ventricles; (3) as a safety valve to reduce pressure above such a block; and, (4) as a means of drainage, irrigation, or instillation of antiseptics or sera in cases of meningitis.

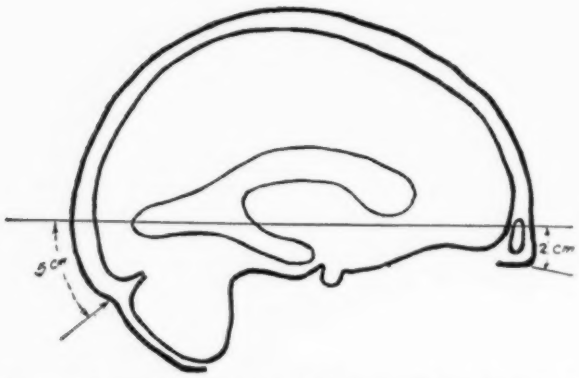


FIG. 1. Composite tracing of a large number of normal ventriculograms. Shows horizontal plane chosen for direction of trocar.

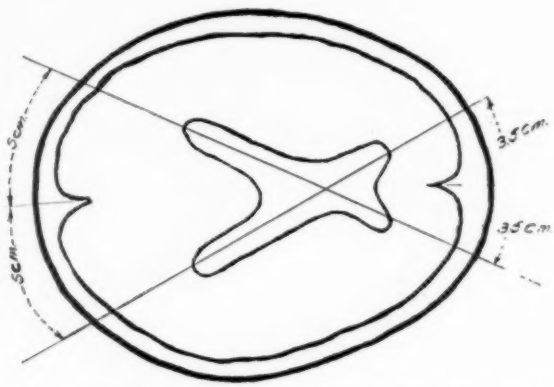


FIG. 2. Composite tracing of normal hardened brains with ventricles filled with air. Shows vertical plane chosen for direction of trocar.

It is fairly generally accepted that ventricular puncture is a major surgical procedure and not to be undertaken lightly and only to be done by one who is able and ready to follow up with a craniotomy if it becomes necessary.

To see an experienced operator thrust a trocar free-handed into a ventricle looks like a simple procedure and it very often is as it appears. But, there are circumstances when it can become very difficult, and at times the ventricle is not reached even after many blind thrusts. Performing it without drapes facilitates the finding of the proper angle of approach by "sighting" the needle. But, there are some who do not care to risk this method and its potential dangers of infection, and we have found it difficult sometimes to sight accurately with the patient draped.

Not being satisfied with the procedure we had been using, we began looking for a method which would permit us to be reasonably certain of hitting the ventricle, with an apparatus which would hold the needle in place, and with the field adequately protected against contamination. We experimented with a number of different devices but finally hit upon this one which has proved very satisfactory during the last five years. A number who have witnessed it have urged that it be described, so this is done with the hope that it may prove of some value to others.

The problem divided itself into several phases: (1) to determine the best point of approach; (2) the proper angles for the needle to take; (3) to develop an apparatus

* From the Neurosurgical Division, Henry Ford Hospital. Submitted for publication November 4, 1931.

to guide the needle, and when desired to hold it in place; the same apparatus to be used bilaterally, if desired.

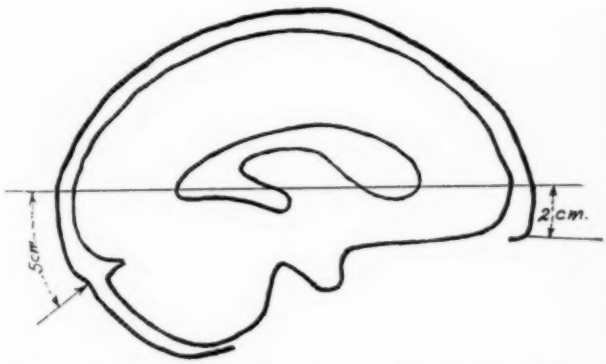


Fig. 3. Composite tracing of normal hardened brains, ventricles filled with air. To check those made by tracing normal ventriculograms.

As to the first problem, the best point of approach, all have generally agreed with Dandy that the vestibule of the posterior horn is the largest target, and likely to be the most constant in location. It is best approached through the fairly "silent area" in the occipital lobe which is lateral to the optic cortical centers, and behind the sensory centers. The different operators vary a little as to the points of approach

superimposed tracings, made a composite drawing (Fig. 1) of the lateral view. For the view from above, we took a number of

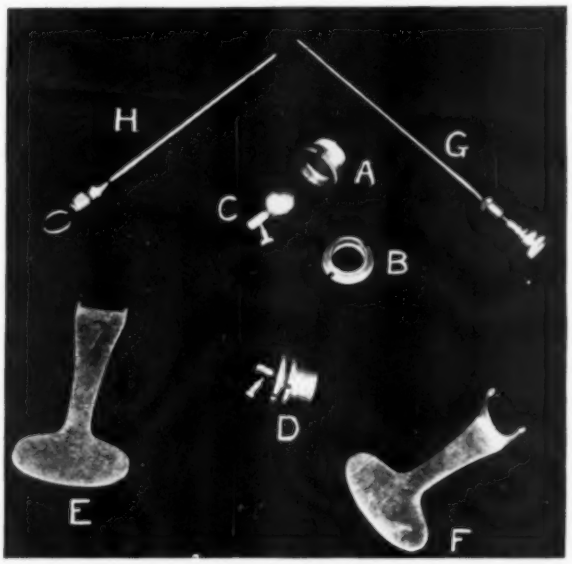


Fig. 4. Trocar guide-and-retention device. A, Outer ring. B, Ring cap. C, Ball guide. D, Device assembled. E, Straight wrench for inserting (A). F, Spanner wrench for applying (B). G, Smaller trocar we use. H, Old larger trocar commonly used.

normal brains hardened in formalin, and took *x*-rays after the ventricles were filled with air. A composite tracing was made of

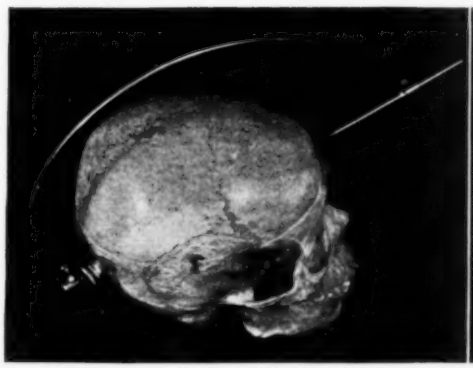

Fig. 5. Wire loop director attached to ball guide. Its proper direction is maintained by locking the guide with the ring cap.

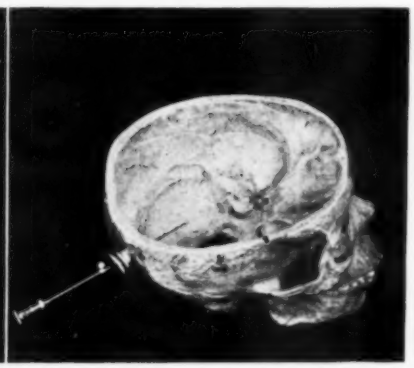

Fig. 6. Trocar locked in place in guide.

and the angles, but in general they use the same target.

In order to work out theoretically the points and angles of approach best for us, we studied a number of films of previous ventriculograms of normal brains, and by these (Fig. 2). This latter material was used to check the lateral views (Fig. 3). The best starting point seemed to be the internal occipital protuberance, as it seemed more constant, and it can always be related to some external bump or groove by study of a previous *x*-ray of the skull. The most favorable horizontal plane seemed to be

one that was 5 cm. up from the protuberance behind (Figs. 1 and 3), and 2 cm. above the supraorbital ridge in front. The

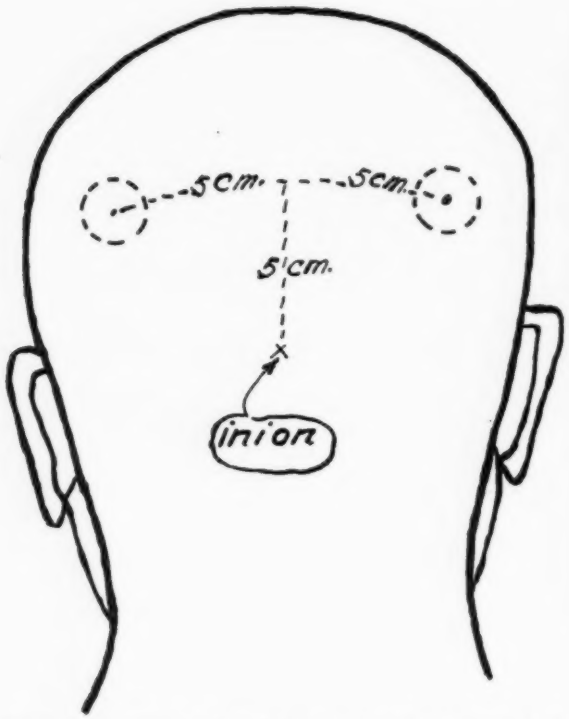


Fig. 7. Diagram of suboccipital region to show position of trephine openings in relation to inion (or internal occipital protuberance).

best vertical plane seemed to be 5 cm. from the midline behind, and 3.5 cm. from the midline in front (Fig. 2). These were checked against at least one hundred actual ventriculograms, and this method has been our routine for five years with satisfactory results.

As to a guide and retention device, we had made and tried out several with adjustable arms fastened to a headband, but found that the simplest and most rigid was one which anchored directly to the skull by screwing into the trephine openings.

Figure 4 shows the device, taken apart, (A, B, and C), and assembled (D). The outer ring (A) is threaded outside to screw into the trephine opening, and inside to receive the ring cap (B) which, when screwed down, clamps the ball guide (C) to maintain the desired angle. This latter has a setscrew to hold the needle while in the ventricle. The wrenches (E) and (F) are for applying (A) and (B) respectively. It should be

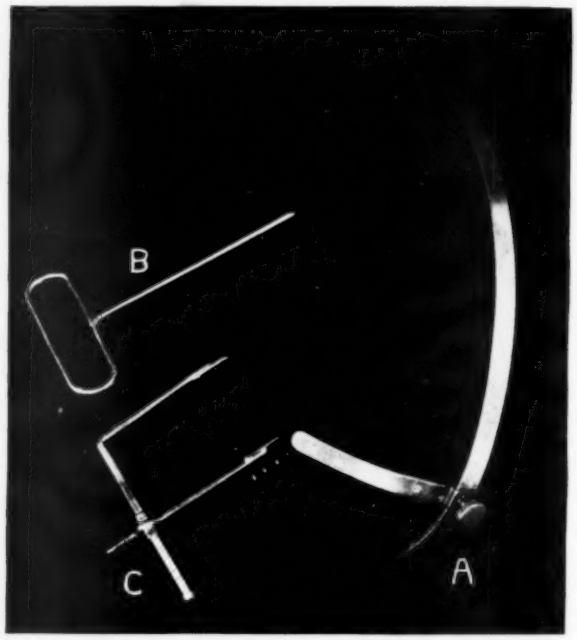


Fig. 8. A, Measuring device for placing marks for position of trephine openings. B, Hand marker used, to mark skull before incision has been made. C, Sliding retractor, useful for any small operation.

pointed out that the trocar (G) we use for brain puncture is one we made here, and is of 17 gauge needle tubing, with a closed tip, and two small holes behind the tip. This needle results in less trauma than the larger one commonly used, (H). It is fitted for Luer connections.

Figure 5 shows a wire loop guide which we use to give the ball guide its proper direction. It is removed when the ring cap has been screwed down to "set" the ball guide in its place. Figure 6 shows the needle introduced and held in place by the set-screws on the ball guide.

The procedure briefly consists of three steps: (1) obtaining the landmarks and marking the points; (2) applying the guide-and-holding devices; and (3) the ventricular punctures and intraventricular maneuvers. The accurate placing of points is essential. The starting point (the point on the skin corresponding to the internal occipital protuberance) can be located by

relating any palpable eminence or depression to the desired point by means of a lateral skull plate taken before the operation. Then the measurements (5 cm. up and 5 cm. to either side of the midline) (see Fig. 7) can be made by hand or by the assistance of such a measuring device as we use (Fig. 8A). The marks can be made with a knife scratch or painted on with silver nitrate stick, or brilliant green. These marks can then be transferred to the skull for greater accuracy by a hand auger marker (Fig. 8B) after the field has been prepared. We have found the easiest way to drape the head is by covering it with a sterile helmet made of heavy unbleached sheeting, which has an opening in the suboccipital region for the operative field (Fig. 9). The head is held in the upright position by the adjustable headrest with pads against the neck under the occipital region. This permits of bilateral puncture, with rotation of the head at will, and by tilting the table the head can easily be lowered to any level to completely empty the ventricles.

FIG. 9. Set-up at operation: Head covered with helmet, wound held open with small retractor, wire loop director clamped in place ready for removal of director.

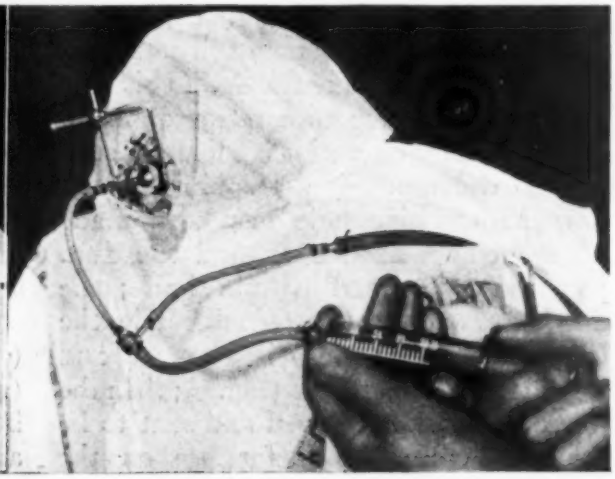

FIG. 10. Set-up at operation. Needle is in ventricle and connected with manometer and syringe by means of a three-way valve.

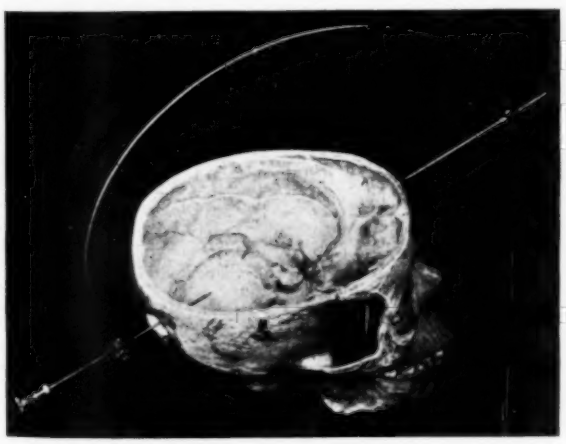

FIG. 11. Wire loop director devised for use where head is not draped or where skin is closed over trephine hole. Apparatus is held immobile by means of short pin posteriorly and long pointer anteriorly until trocar has entered ventricle.

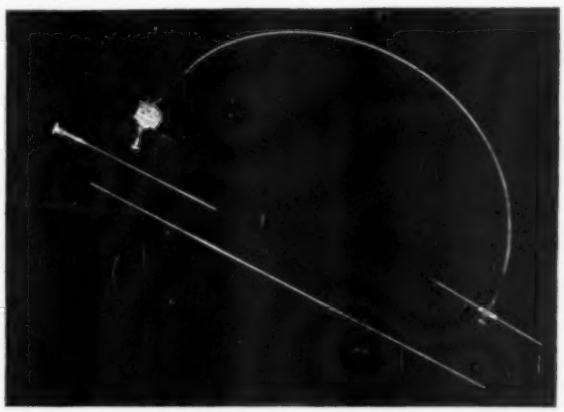

FIG. 12. Wire loop director with hinged-groove guide opened, permitting removal from needle which is in ventricle.

After the skin has been blocked with novocaine and the marks have been transferred to the skull, the incision is made and Michel clips attaching the stockinet-cover for hemostasis and protection[1] the wound is kept open with the small self-retaining retractor shown in Figure 8c. (This has also proved of value as a retractor in all small exposure operations such as subtemporal decompression, trephining, etc.) After the trephine hole has been made with a medium-sized burr, and the dura inspected and nicked with a knife; the guide is screwed into the trephine hole, the wire loop guide (Fig. 5) is attached and the guide ball properly set (Fig. 9); then the wire guide can be removed and sent to be resterilized, preparatory for use on the other side. All is then ready for the needle thrust. The syringe, three-way rubber tube connection, and monometer are put in readiness and connected with the needle (Fig. 10), after it has entered the ventricle and the setscrew has been tightened, fixing the needle in place. One can then proceed to empty the first ventricle, or repeat the procedure on the other side and place a guide and needle in the opposite ventricle. One is then prepared for the simple emptying procedure, or any maneuvers he may wish.

The criticism may be made that this is too complicated a procedure to be justified as a routine. It may be unnecessary for experienced operators, and where no difficulties are to be encountered; but we feel certain that we have been saved some failures and have avoided some unnecessary trauma to the brain by sticking to a mechanically accurate procedure in preference to the freehand method. Also, this permits of simultaneous bilateral work which at times is of value. In over 200 ventricular punctures, the only ones we have missed are those where either the ventricle was displaced or some error was made in placing of the marks. The latter should be very rare if care is exercised.

The flexible cross-shaped measuring rule (Fig. 8A) and the hand auger marker (Fig. 8B) may be unnecessary refinements, but they do facilitate and make for accuracy and are very useful at times.

A modification of the wire loop guide has recently been devised (Figs. 11 and 12) for use where complete draping is not desired or when the wound is closed as at subsequent punctures. The needle is guided through a groove which lies between two small metal plates which are hinged together and can be opened by loosening a setscrew. This groove points accurately towards the opposite pin which is held against the outer target. The whole loop is sterilized for use, but only the rear part need be kept so during the procedure. As soon as the needle has struck the ventricle the guide can be removed, the needle being left in place (Fig. 12). With such a device any point of approach and any target can be used. The needle must of course be held in place by hand with this method.

[1] Crawford, A. S. Craniotomy incisions without forceps. *Arch. Surg.*, 17: 472–4, 1928.

# THE SIGNIFICANCE OF LABORATORY STUDIES IN GASTRIC AND DUODENAL ULCERS*

J. WILLIAM HINTON, M.D., F.A.C.S., AND SOPHIE FRANKEL, B.S.

NEW YORK

THE results of complete laboratory work done in 141 ulcers by one of us (S. F.) have been reviewed and the findings evaluated. The cases admitted to our clinic have had positive diagnoses made before being registered, as this is a "refer clinic" and the patients either come from the 4th Medical or Surgical Division, Bellevue Hospital. The majority have received no previous treatment but a few have had medical treatment in other institutions, and some have been operated upon elsewhere before coming under our observation.

There is a definite laboratory routine for each new patient which consists of an Ewald test meal, complete blood count, urinalysis, Wassermann test, stool examination and blood chemistry, including urea, non-protein, creatinine, sugar, chlorides, calcium and phosphorus determination. Some have had agglutination and sedimentation tests but these are excluded from this report.

In studying ulcer cases one is interested in detecting some means of determining which cases will offer a favorable prognosis under conservative treatment, and also those liable to hemorrhage, and hence to perforate, or cause associated chronic conditions. Chronic cholecystitis has been stressed as a frequently correlated lesion of ulcers, but biliary infections have probably been overemphasized and pancreatic infections minimized as a complication which, when present, offers a poor prognosis for conservative treatment. Hurst and Stewart[1] have stated in their book on "Gastric and Duodenal Ulcers" that an analysis from Leeds of 232 autopsies revealed the pancreas formed a part of the floor of the ulcer in 24.4 per cent of cases, and the liver only 4.3 per cent. They likewise report a clinical series from Leeds of 183 cases of partial gastrectomies in which the pancreas formed a part of the floor in 19.7 per cent of cases, and the liver 2.2 per cent. One can see from this report that pancreatic involvement, in ulcers, is present in a high percentage of cases.

We have several postoperative cases of chronic pancreatitis associated with ulcers that are being followed in the clinic. It has been our belief that pancreatic involvement is the one associated lesion that should be diagnosed so as to determine when conservative treatment shall terminate and surgery be recommended. With that in mind a review of the complete laboratory work has been undertaken with the hope that some aid could be obtained from this study which would influence the prognosis in the difficult cases.

Of this group, which numbered 141, there were 126 unoperated cases which consisted of 108 duodenal ulcers, 14 gastric, 1 pyloric and 3 double ulcers, meaning a lesion in both the stomach and duodenum. There were 15 postoperative cases in the series, these patients having been operated upon in other institutions and coming under our observation for recurrent or persistent symptoms, which included 9 gastroenterostomies, 2 partial gastrectomies, 4 simple closures; and in 1 gastroenterostomy a definite jejunal ulcer was proved. Of the unoperated cases in this group there were 9 cases that came to operation in spite of every attempt to relieve the patients of their symptoms by medical management and of this number one was operated upon for hemorrhage and 8 for persistent pain. Of the 8 cases, 4 had an associated chronic pancreatitis.

*Blood Chemistry.* We have taken only those cases in which all the laboratory data

[1] Hurst, A. F., and Stewart, M. J., Gastric and Duodenal Ulcers. Oxford Univ. Press, 1929, pp. 106 and 189.

* Submitted for publication August 25, 1931.

were complete and this has consisted of non-protein nitrogen, creatinine and sugar by the Folin-Wu method, urea nitrogen by the Van Slyke, chlorides by Whithorn's method, calcium by Kramer-Tisdall and phosphorus by Bell and Daisy method. Our findings were within normal limits in this group and in spite of several cases having a six hour retention varying from one-third to one-half of the motor meal at the end of six hours, there was no disturbance in the chlorides, and the sugar findings were not altered in any of the cases, although we had 4 cases of chronic pancreatitis proved by operation.

*Urinalysis.* In this series there were no cases of glycosuria, but Hurst and Stewart reported 3 cases associated with duodenal ulcers in which the urine became negative after the patient was put on treatment for the ulcer and became symptom-free. This is not in accord with our understanding of chronic pancreatitis, as the lesion is an interlobular affection and does not involve the intralobular connective tissue, or affect carbohydrate metabolism. In a previous report[1] on chronic pancreatitis the sugar metabolism was not disturbed.

[1] Hinton, J. W., Chronic interlobular pancreatitis. To be published.

*Gastric Analysis.* The test meal of Ewald and Boas consisted of 2 slices of bread without butter, and 1½ glasses of water, the contents being withdrawn one hour from the time the patient began to eat. In Table I, it will be seen that most of these patients had a high free and total acidity, but in those cases showing satisfactory progress under medical management, the acidity showed relatively little change. The gastric contents have been studied for the presence or absence of bile and Table II will reveal that 24 cases had bile present, but what part this plays in the prognosis I am not prepared to say.

TABLE I

GASTRIC ANALYSIS

| | Duodenal | | Gastric | | Marginal or Jejunal | | Pyloric | | Postoperative | | Double | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Free HCl | Total Acid | Free | Total | Free | Total | Free | Total | Free | Total | Free | Total |
| 0–10 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10–20 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20–30 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 |
| 30–40 | 9 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 40–50 | 13 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 |
| 50–60 | 15 | 8 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 60–70 | 27 | 14 | 3 | 0 | 1 | 0 | 0 | 0 | 4 | 4 | 0 | 0 |
| 70–80 | 22 | 22 | 3 | 3 | 0 | 0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 80–90 | 9 | 20 | 2 | 3 | 0 | 1 | 0 | 0 | 1 | 4 | 0 | 0 |
| 90–100 | 4 | 18 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 100–110 | 3 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 110–120 | 1 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120–130 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130–140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 140–150 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 108 | 108 | 14 | 14 | 1 | 1 | 1 | 1 | 15 | 15 | 2 | 2 |

*Complete Blood Count.* This offers us a means of detecting an anemia or active infectious process. Great stress has been laid on the high percentage of cases with occult blood in the stools. If this be so then we would expect to find a secondary anemia in a relatively high per cent of cases but in only 3 cases was secondary anemia present, 2 of these having had a recent gross hemorrhage; the other was suffering from bleeding internal hemorrhoids. A number of the cases with the findings of occult blood must bear no relation to the ulcer; in all probability these come from meat in their diet. Leucocytosis

has been stated to occur in active and extensive ulcers but we found only 2 cases with a leucocyte count of 10,000 and one with a count of 13,500, and in all other cases both their leucocyte and differential count was within normal limits.

Table II

BILE IN GASTRIC CONTENTS

| Bile | Duodenal | Gastric | Marginal | Double | Postoperative |
|---|---|---|---|---|---|
| Plus 1 | 3 | 0 | 0 | 0 | 0 |
| Plus 2 | 4 | 1 | 1 | 1 | 1 |
| Plus 3 | 3 | 0 | 0 | 0 | 0 |
| Plus 4 | 6 | 0 | 0 | 0 | 4 |
| Total | 16 | 1 | 1 | 1 | 5 |

*Wassermann Test.* Syphilis is, of course, a fairly frequent disease and syphilitic ulcers have been reported but in this group we found only 2 positive Wassermann reactions, one being gastric and the other a duodenal ulcer; but as neither of these cases has come to operation it cannot be stated whether they were syphilitic in origin or not.

*Stool Examination.* Although the patients were instructed to bring specimens the majority failed to do so and in only one-third of the total number of cases was the stool examined. Of this number 40 per cent had a positive diagnosis of blood.

*Comment.* As previously stated each of our cases has had a positive diagnosis of an ulcer before being registered in the clinic and the laboratory work has been done with the hope of obtaining some information that will be of prognostic value. From a review of this series it seems that a diagnosis of ulcer is dependent on the history, physical examination and roentgenological findings. After treatment has been instituted we are still forced to look to the same criteria to determine the progress of the case, as the laboratory work has not been of any very great aid from a prognostic standpoint, although we are continuing, essentially, the same routine. If some method of determining pancreatic infection could be found it would greatly simplify the handling of borderline cases. Physicians who have had extensive experience with gastric and duodenal ulcer realize that the indications previously given for operation are not true indications for operation, as most of these will respond satisfactorily to medical care, but the one indication for surgery is persistent pain in spite of the different methods of medical care and the pain in the majority of instances is due to an associated chronic pancreatitis. It would seem that until we have some means of detecting the pancreatic involvement associated with ulcers, patients in whom medical treatment is contraindicated will continue to have it, and other patients who can be cured by conservative treatment will be operated upon when surgery is contraindicated.

Rowe and McManus[1] have recently called attention to the importance of doing the galactose tolerance test in cases of hepatic dysfunction and state:

> In a series of previous papers the writer and his associates have discussed the normal human tolerance for galactose and a variety of factors exercising influence on its level. The present paper deals with influence of hepatic dysfunction as determined by objective methods on the power of the organism to utilize this sugar. The use of galactose for function testing was first suggested by Bauer in 1906 as a means of evaluating the levels of hepatic activity, but the failure of the subsequent observers to recognize intrinsic sex and age differences and the lack of uniformity in the criteria adopted led to seemingly contradictory results and gradually caused its discontinuance as a test substance. Its use has been revived by the senior author, after a careful and extensive study of the conditions limiting its application, and today it forms the basis of a quantitative vital function test of wide applicability and differential significance.

As the routine work done in this series is of very little aid in prognosticating the outcome it would seem that the galactose tolerance should be routinely tried.

[1] Rowe, A. W., and McManus, M., The metabolism of galactose. IX. The influence of hepatic dysfunction on tolerance. *Am. J. Med. Sc.*, 181: 777, 1931.

# SUBMUCOUS PERINEOPLASTY*

W. Wayne Babcock, M.D.

PHILADELPHIA

RELAXATION and laceration of the vaginal outlet produce a condition similar to that of hernia. There is a canal through which structures from within the body tend to protrude, an orifice or ring and a lack of supporting muscular and ligamentous structures. When the normal supports to the canal are insufficient protrusion occurs. As with a hernia, the restoration of the supporting structures, the obliquity and the narrowing of the canal are important factors in overcoming the abnormality. As with a hernia, united muscle, that it may continue to give support in the perineum, should be backed by a plane of fascia or aponeurosis. Muscular substance is soft and sutures introduced into muscle, under stress, tend to cut through or tear out unless an overlying or underlying strong fibrous layer is so sutured as to support the muscle and relieve it of strain.

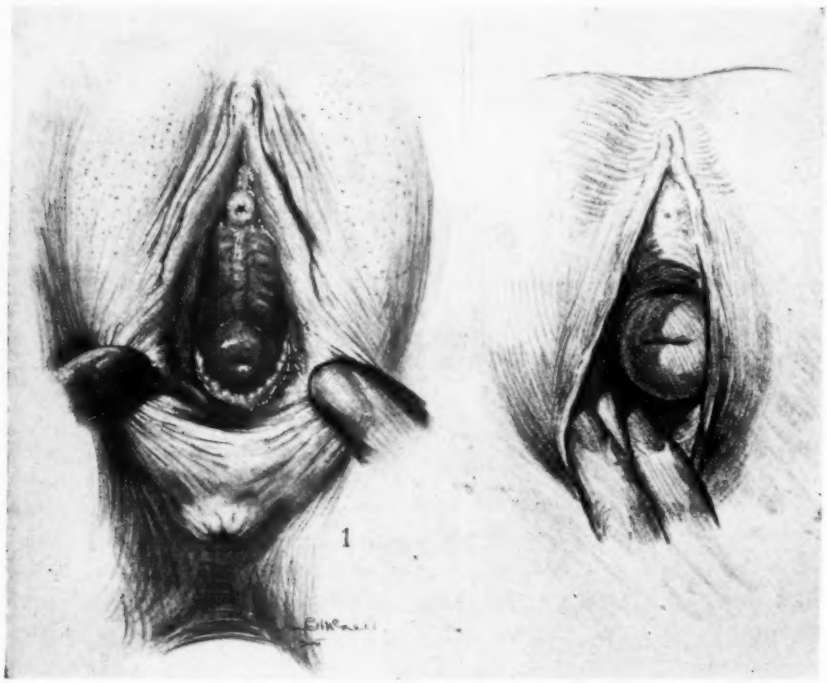

Fig. 1a. Relaxed perineum with lack of support of pelvic contents.

Fig. 1b. Demonstration of margin of levator ani.

Like the inguinal canal, the vagina runs nearly parallel with the skin. The finger passed to the cervix may be palpated by the external hand at the side of the coccyx. Underneath the vagina is slung the great muscular support of the pelvic floor, the levator ani (pubococcygeus) muscle. In the stress of labor, this muscle may be pushed off to the sides of the vagina, with lowering of the pelvic floor. A laceration completely across the levator ani from natural forces is almost unknown. Above the levator is the rectovesical fascia, below the levator fascia. More superficial to the muscle and lateral to the vaginal outlet, lie the two layers of the triangular ligament (fascia trigoni

* From the Surgical Department, Temple University. Read at the 44th annual meeting of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, White Sulphur Springs, W. Va., Sept. 14–16, 1931.

urogenitalis inferior and superior) between which runs the thin and rather inconspicuous transversus perinei profundis. Between

For the vagina and skin a continuous buried submucous and subcutaneous stitch of No. 00 plain catgut is used. For the

Fig. 2. Fig. 3. Fig. 4.

Fig. 2. Transverse incision just below carunculae.
Fig. 3. Incision through the triangular ligament and levator fascia to levator ani.
Fig. 4. Margins of levator ani liberated and withdrawn.

the skin and the lower layer of the triangular ligament is a superficial perineal fascia, the fascia of Colles. There is therefore ample fascia to be used for support to the united pubococcygeus muscle. To unite the layers of fascia and muscle properly, access is best obtained by an incision passing through or near the cutaneous surface.

The shortened and widened vagina should be lengthened and narrowed. The wide edges of the liberated levator ani may then be united under and to the sutured vagina. The supporting fascial layers of the muscle, triangular ligament, the fascia of Colles and the skin may in turn be sutured, giving a very satisfactory perineal support. This type of perineoplasty suggestive of an operation for hernia, I first put into practice in 1902,[1] and have continued to use with but slight modifications until the present time. An adequate exposure of each layer is obtained and from its convenience and efficiency, we prefer to use separate layers of buried catgut suture.

[1] Babcock, Submucous perineorrhaphy. *J. A. M. A.*, May 15, 1909.

muscular and fascial layers, interrupted single or double loop or mattress sutures of No. 0 or 1 chromicized catgut are employed. Others have modified the operation by introducing through-and-through sutures, without, however, changing the essential plan of the procedure. Buried catgut has in our hands given such excellent results and such a desirable emancipation from the difficulties and complications that attend the removal of insoluble sutures, that we have found no reason to discard it.

As a rule, no tissue need be removed from the vaginal wall. The redundant tissue, properly sutured, is useful in elongating the shortened vagina and in restoring those normal folds and sulci which give the vagina an H shape on transverse section, and which are a bar to the development of a rectocele. Of course, there are occasions when the resection of greatly altered or very cicatricial vaginal tissue is desirable. This, however, is not an essential part of the operation.

Early experience indicated that wide, thick surfaces of the levator ani should be

apposed by suture. If the edges of the muscle only are brought into apposition, the muscle will often retract, leaving a thin perineal wall with insufficient support. By uniting the edge with a wide margin from the superior surface of the muscle and with adequate fascial support, we may overcome this tendency.

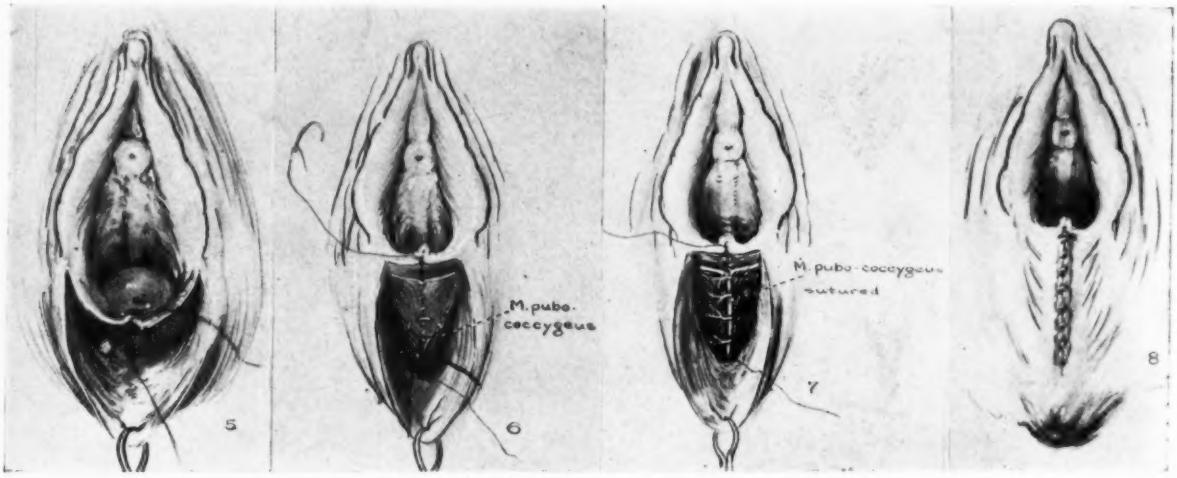


Fig. 5. Fig. 6. Fig. 7. Fig. 8.

Fig. 5. Closure of posterior vaginal wall by continuous submucous suture of 00 catgut.
Fig. 6. Suture of levator ani muscle.
Fig. 7. Completion of suture of levator ani.
Fig. 8. Triangular ligament and fascia have been united over levator ani by buried sutures. Skin is usually closed by a subcutaneous continuation of suture No. 1.

## TECHNIQUE

The parts having been shaved and carefully asepticised, a thick pad of sterile gauze is fastened over the anus. Any necessary preliminary operations upon the cervix, uterus and anterior vaginal wall are first performed. The labia majora are now separated and retracted by the index fingers of assistants and a knife or the sharp point of a pair of scissors is entered into the subcutaneous cellular tissue just internal to the orifice of a Bartholin's gland. The incision is carried around the posterior margin of the introitus, along the carunculae to a corresponding point near the orifice of Bartholin's gland on the opposite side. Laterally, the tissues are separated to the surface of the triangular ligament. Great care should be used in freeing the vagina in the midline to avoid entering the rectum. Unless there is an unusually large rectocele, any extensive liberation of the vaginal wall from the rectum is unnecessary. Should it be deemed advisable to open the recto-vaginal septum, it is wise to begin laterally, separating the tissues from the sides toward the midline. A tenaculum forceps is fastened to the skin at the middle of the posterior edge of the incision, from which it is permitted to hang as a retractor. An edge of the levator ani muscle is now located between one finger placed against the lateral wall of the vagina and a second finger or the thumb placed in the depth of the corresponding side of the wound. With the edge of the muscle thus located, the layers of the triangular ligament and levator fascia are penetrated by the thrust of a pair of Mayo scissors, the blades of which are then opened and withdrawn. If preferred, the incision may be made by a scalpel. The opening in the fascia is enlarged by knife or scissors, freely exposing the edge of the levator ani muscle, the inferior and superior surfaces of which are well freed by the fingers so the muscle may be grasped by a tenaculum forceps and pulled into the wound. The opposite muscle is similarly located and partially withdrawn

through a corresponding opening in the triangular ligament.

With a curved needle and No. 00 plain catgut the posterior vaginal wall is now united in the midline, beginning with what was formerly the posterior commissure. This continuous suture catches the submucosa only and one end is left long and hangs over the perineum. The middle of the upper border of what was a transverse incision is thus united in a vertical manner, lengthening and restoring the posterior wall of the vagina. If the posterior vaginal wall is very redundant, an additional row of sutures may be applied catching the rectovaginal fascia lateral to the suture No. 1, and so rolling the submucous tissues together that the convexity on the mucous surface of the posterior vaginal wall is accentuated. Suture No. 1 which has thus made a partial submucous closure is now temporarily laid to one side to be completed later.

By mattress or double loop sutures of No. 1 chromicized catgut catching an ample bite from the edges and superior surfaces of the levator ani, a broad surface of these muscles is united in the midline. Posteriorly these sutures may be so applied as to reinforce the trigone, sphincter ani and transversus perinei superficialis. Care should be taken that the levator muscle is not united so far anteriorly as to unduly constrict the vaginal orifice. Some of these sutures also catch the overlying fascia, or submucosa to avoid a "dead space." The new muscular supports will now be observed to cause the vagina, perineum and anus to ascend to a higher and more anterior position so that an anterior deflection of any force from the abdomen toward the pubis will result.

To support the united levator ani the inferior fascial planes are now sutured. The lateral edges of the openings through the fascial trigone and levator fascia are united from side to side by interrupted sutures of No. 0 or No. 1 chromic catgut, closing the posterior part of the urogenital trigone.

The superficial fascia may now be united by a few sutures of No. 00 plain catgut. The operation is completed by continuing suture No. 1 first as a submucous and then a subcutaneous suture until the posterior angle of the incision is reached, when it is tied to the initial or lower end of this suture.

The knot is permitted to sink under the skin and the ends are cut short. As the various layers of united mucosa, muscle, fascia and skin are compactly bound together, there is little "dead space" and drainage is unnecessary. A hematoma is to be avoided by keeping lateral to the bulbs and by ligating any bleeding vessels. As a rule there is little hemorrhage and ligatures are not required. A narrow wick of gauze is introduced into the vagina, the end of which hangs over the external wound. A sterile supporting pad held by a T-bandage is applied. A catheter is used for two days when the gauze is removed. For wound irritation a 22 per cent yellow oxide of mercury ointment is applied.

The patient usually sits up on the tenth to the twelfth day, and is discharged from the hospital at the end of two weeks; but should resume her house duties only after six weeks. The chief features of the operation are the elongation and narrowing of the vagina without sacrifice of tissue, the clear visual demonstration of each anatomical structure involved, and the accurate suture from within out of each supporting layer. If this is precisely accomplished, the material and method of suturing are considered relatively unimportant. In such an anatomical closure in layers, if the incisions and sutures are carried too far anteriorly an undesirable narrowing of the orifice may result.

# A STUDY OF 1200 CERVICES

## INCLUDING 589 CASE HISTORIES, 3500 MICROSCOPIC SECTIONS AND THE GROSS SPECIMENS OF 1200 BIOPSIES*

JAMES E. DAVIS, M.D.

ANN ARBOR, MICH.

THIS study is chiefly concerned with the assembled significances of tissue traumata, infection, and repair preceding malignancy as seen in a large series of cases supplying biopsy material.

The wealth of material in this series has been marshalled under the divisions of: Importance of the selection of biopsied tissues; the histopathology; cross section studies of clinical data; considerations of treatment; and summary.

### BIOPSIES

In the selection of biopsy material, diagnostic responsibility divides between the clinician and the pathologist. The tissue section may be taken almost haphazardly or after due consideration for the ocular appearance and palpatory information. The ocular examination may be systematized by noting: (a) malformative, (b) vascular, (c) inflammatory, (d) degenerative, and (e) neoplastic changes.

The malformations will include hypertrophy, hyperplasia, atrophy, scars with their indentations, ulcerations and neoplasias. A malformation of position is important, especially that of descensus in disposing to elongation of the cervix and ulceration but not to neoplasia. It is rare to find reported cases of complete descensus and coexisting carcinoma.

Hypertrophies, hyperplasias, ulcerations, atrophies, scarring and neoplasias show frequent associations with vascular changes. The first three are observed accompanying vascular hyperactivity, while the second group have vascular hypoactivity.

The frequency of infections in association with hypertrophy, hyperplasia, ulcerations and neoplasias is well known and should always be kept in mind when inspecting the cervix.

An effective ocular examination will obtain information as to size, color, form, position, discharge, loss of tissue, irritation, presence of cysts, scars, benign and malignant new growths. Additional information is obtained by grouping certain of these observations and proceeding at once to palpation.

In most instances, when the diagnosis is concerned with early stages of malignancy, the cervix should be examined in two imaginary planes. The more nearly normal half should be recognized by combined ocular and palpatory guidance and should receive first attention. The second half can next be subjected to both comparative and exclusive examinations.

The posterior lip will be found more frequently the site of pathology. The margin of the portio is the site of most carcinomas, and the growth in its earlier stages is in most instances shallow, partly eroded or ulcerated, and slightly softer than normal epithelium. The adjoining tissue is denser than normal and the area involved has the appearance of being chronically inflamed at or very near the site of an old laceration. The suspected tissue, if stained, will absorb enough more pigment to make a contrast with the uninvolved tissue about it. If a thin sharp knife is used and section is made through the carcinomatous tissue, the resistance is quite exactly comparable to the resistance of raw potato or carrot tissues. History of previous childbirth, miscarriage, instrumental trauma, gonorrhea or other infec-

*Read at the Forty-fourth Annual Meeting of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, White Sulphur Springs, W. Va., September 14–16, 1931.

tion with leucorrhea, will always add to the sum total of obtainable data favoring malignancy.

The biopsy section should be $1.5 \times 5$ cm. and obtained by cutting from the shoulder of the portio upwards through and past the internal os for about 0.5 cm. In this series of 1200, 253 sections had been taken without inclusions of squamous epithelium and 300 were without gland tissue. The histopathological diagnoses consequently became reduced approximately 25 per cent, or in other words their efficiency reached only 75 per cent, solely because of incomplete biopsy sections. This would constitute a serious omission for clinicians who rely implicitly upon the biopsy diagnosis.

## HISTOPATHOLOGY

It is distinctly advantageous in reading a large number of slides to follow certain routine procedures. Accordingly, in this study the stratified epithelium received first attention, the glandular epithelium came second, and the stroma last.

One may observe if all, part or none of the stratified epithelium is of primary (or original) type, or if it is all or part of repair or metaplastic type, and whether young or old repair epithelium, and lastly, if this tissue displayed is part normal, part repair, part metaplastic, or part or all of neoplastic character.

The non-neoplastic stratified epithelium may be strikingly hypertrophic, hyperplastic, deformed, atrophic and keratinized. The hypertrophy will sometimes result from old lacerations compelling piling up of the layer. In certain instances hyperplasia and hypertrophy may result from overactivity of the anterior pituitary lobe. In virgins with a constitutional tendency to hypertrophy of mucous membranes and adenoid tissue elsewhere in the body, the cervix may show marked hypertrophy. Malposition is a frequent cause of cervical hypertrophy and hyperplasia because of long-continued passive congestion. Doubtless infection is the most frequent cause of both hypertrophy and hyperplasia.

The loss of stratified epithelium followed lacerations, infections, ulcerations, and erosions.

Metaplasias occurred in the presence of infections, lacerations, erosions, and neoplasias.

Neoplastic, stratified epithelium showed a very strikingly close association with chronic infection, old trauma, scarred stroma, metaplasia, ulceration, and irritated repair epithelium.

Glandular epithelium of the cervix is observed in changed and abnormal positions in conditions of dilatation from obstruction, with indwelling or contiguous infection, in hyperplasias, metaplasias and neoplastic new growths. The frequency of glandular erosion and retention cyst formation as sequelae of traumata and infection is impressive.

Stromal changes exhibit inflammatory processes in their various phases and sequelae. The stroma displays neoplastic advances. The time period of its use as a field of process activity is chiefly displayed in vascular fibroblastic and fibrocytic conditions.

The crux of histopathological work is reached in the study of cervical tissues when all processes are correlated in progressive chronic conditions that may lead to malignancy. Judgment and experience gained after perusal of the best in the literature and tested against the values learned by clinical controls, become more and more certain in diagnosis.

There is no other field where malignancy can be so advantageously studied as in the cervix, affording as it does:

a. Accessibility.

b. Frequency of occurrence.

c. Localization.

d. Specific association in perhaps 100 per cent of occurrences with trauma, infection and continued irritation and 90 to 98 per cent with childbearing.

e. Age of lesion incidence (not the age of patient necessarily).

f. Availability of biopsy tissue before, during and after treatment.

g. Accumulation of large files of tissue sections.

The material in this series of 1200 cervices contained stratified epithelium in 947 cases, glandular epithelium in 900 cases, and stroma in 1200 cases.

Inflammatory reactions were observed in 777 different tissues. Of these, one only was tuberculous, and 8 were syphilitic. Degenerative changes were present in 725 different sections. Benign new growths were present in 35 cases, polypoid hyperplasias in 16 cases. Evidence of pregnancy was present in 15 cases. Malignant neoplasms occurred in 185 cases. Of these, 170 were epidermoid carcinomas, 12 were adenocarcinomas, and 3 were sarcomas. Metastatic carcinoma from the rectum occurred once. Procidentia was observed in 26 cases.

In one's search for malignancy the stratified epithelial behavior is of first importance. The most unstable epithelium is that which is most immature. This immature epithelium is destined to complete differentiation and to mature the cell units in size, resistance, form and function. The producing or genetic cells are those of the basal line. The young immature cells produced are just above the basal line and make up the intermediate zone. The surface or scale-like cells are ripened units containing some amount of keratin.

The embryonic stratified epithelium of the cervix has apparently no natural liability to malignancy. Cervices that are not lacerated or infected, rarely, if ever, become malignant. The constant appearance of the area of malignancy exhibiting injury, irritation, infection, derangement of cells and undue growth stimulation, is convincingly evident. These influences when continued over a long enough period from the basal side of the layer, affect the embryonic cells in such a way as to prevent their differentiation and maturation going much beyond the stage where only the ability to reproduce is reached.

TABLE 1

HISTOPATHOLOGY IN 1200 CERVICES

| | | Cases |
|---|---|---|
| *Tissue histology:* | | |
| Stratified epithelium | | 947 |
| Glandular epithelium | | 900 |
| Stroma | | 1200 |
| *Pathology:* | | |
| Inflammation: | | 777 |
| Purulent | 18 | |
| Luetic | 8 | |
| Tuberculous | 1 | |
| Abscess | 1 | |
| Degeneration: | | 725 |
| Laceration | 725 | |
| Erosion | 721 | |
| Retention cysts | 367 | |
| Fibrosis (stromal) | 340 | |
| Fibrosis (vascular) | 267 | |
| Fibrosis (grade 1) | 12 | |
| Fibrosis (grade 2) | 99 | |
| Fibrosis (grade 3) | 139 | |
| Fibrosis (grade 4) | 16 | |
| Epithelial repair | 287 | |
| Ectropion and cornification | 200 | |
| Ulceration | 86 | |
| Thrombosis | 5 | |
| Calcification | 3 | |
| Neoplasia (benign): | | 34 |
| Fibroma | 1 | |
| Myomata | 7 | |
| Polyps | 26 | |
| (Polypoid hyperplasia) | 16 | |
| Endothelioma | 1 | |
| Neoplasia (malignant): | | 186 |
| Epidermoid carcinoma | 162 | |
| Adenocarcinoma | 12 | |
| Papillary carcinoma | 8 | |
| Metastatic carcinoma (from rectum) | 1 | |
| Sarcoma | 3 | |
| Stage of maturity: | | |
| Unripe | | 71 |
| Midripe | | 61 |
| Ripe | | 39 |
| Radio-sensitivity: | | |
| Grade 1 | | 38 |
| Grade 2 | | 61 |
| Grade 3 | | 43 |
| (Less than one) | | 22 |
| Addenda: | | |
| Procidentia | | 26 |
| Decidual cell infiltration | | 15 |

When denudation of the stratified layer has occurred and the ultimate repair phase of production has been accomplished, it makes a great difference whether this epithelium is the first or later generation of repair cells. The youngest cells are least tolerant and succumb easily to neoplastic changes. A layer of this repair epithelium usually has but few, if any, scale cells

with hyalin and keratin present. The middle layer is made up of hyperchromatic, incompletely developed cells that have been contacted by the inflammatory cells and products over a long period of time. The effect upon these immature cells is overstimulation, resulting in rapid multiplication, accomplishing only the function of reproduction.

The basal cells become irregular in position and form and produce cells of different sizes and staining characteristics. The cell individuality is greatly changed, nuclear division being sometimes seen.

Malignancy occurs in ulcers of long duration at the stage when proliferation is active. There has been re-stimulation of the tissue by irritants. The proliferating downgrowths become involved with loss of the basal cells and exposure of the embryonic cells to the irritating inflammatory products.

The cervical glands are very resistant to injury and cell change occurs only as a response to the prolonged and virulent form of irritation.

It is in metaplasia, gland production, and irritation, and seldom otherwise, that malignancy occurs in these glands.

## CLINICAL DATA

(*A Cross Section of 150 Cases, Hospital A*)

1. The cases of cervicitis and endocervicitis without a single exception gave evidence of some degree of laceration.

2. The chief complaints recorded for this group were as follows:

| | Per Cent |
|---|---|
| Pain in the lower abdomen | 48 |
| Leucorrhea | 32 |
| Pain in the back | 16 |
| Irregular menstruation | 12 |
| Dragging sensation in the pelvis | 12 |
| Fainting spells | 8 |

3. The symptoms in group 2 in many instances were variously associated and in other instances a single symptom prevailed as a subdominant complaint in a higher percentage of the patients. Leucorrhea, for example, prevailed in 88 per cent of all cases through variable periods of time that always dated back to the last childbirth. Twenty-eight per cent of all the patients complained of dragging sensation in the pelvis but did not give this symptom first importance. In the 12 per cent listing this symptom first, there was usually a retroverted position of the uterus.

In the group giving pain in the back as the most important symptom, all had a history of severe laceration following hard long labors in which instrumentation had been used in many instances.

In 28 per cent of the cases having had hard labors and lacerations of varying degrees, there were sequelae of irregular menstruation. In a number of cases severe dysmenorrhea occurred with prolonged and profuse bleeding lasting seven to nine days. In others there was suppressed menstruation once in two to three months.

When headache occurred, as it did in 4 per cent of the cases, it was severe and of occipital or frontal type. It usually came on in the morning and lasted from one to four hours.

Hemorrhage occurred as a sole chief complaint in 8 per cent of this series. Twenty per cent, however, listed hemorrhage as a symptom with which was associated excessive flow during and after menstruation. As a sequel there followed secondary anemia of variable severity and duration.

In 12 per cent of the 150 cases with malposition of the uterus, there existed deep cervical tears in the vaginal vault.

(*A Cross Section of 639 Cases, Hospitals B and C*):

From hospital B, 62 consecutive clinical records with accompanying reports of tissue diagnosis were studied and combined with 377 similarly completed records from hospital C.

The analyses included age incidence, marital state, pregnancies, cardinal symptoms, and variations in menstruation.

*Age Incidence:*

| Years | Cases |
|---|---|
| Under 20 | 3 |
| 20 to 30 | 125 |
| 30 to 40 | 188 |
| 40 to 50 | 77 |
| 50 to 60 | 35 |
| 60 to 70 | 9 |
| Over 70 | 2 |

*Marital State and Number of Pregnancies:*

| | Cases | Per Cent |
|---|---|---|
| Nullipara | 57 | 12.2 |
| Married and childless | 39 | 8.8 |
| One child or one miscarriage | 59 | 13.4 |
| Two or more children | 274 | 63.3 |

Of the entire group of 439 patients 31 were colored, 408 were white. Forty-six of the patients were Jewish.

*Menstrual Disorders:* Fifty-eight per cent of the series gave menstrual disorders as chief complaints. Of this group menorrhagia occurred in 12 per cent and metrorrhagia in 24 per cent.

*Leucorrhea:* Forty-nine and six-tenths per cent or 218 of the group complained of leucorrheal discharge.

*Pain:* Fifty per cent of the patients complained of abdominal pain; 32 per cent described the pain as associated with a bearing-down feeling in the lower abdomen.

*Backache:* This symptom was present in 28 per cent of the patients. Fully 25 per cent gave a history of this complaint existing since the last pregnancy.

*Cervical Pathology:*

| | |
|---|---|
| Cervicitis was evident | in 414 cases (or 96 per cent) |
| Laceration and erosion | in 213 cases (or 49 per cent) |
| Prolapse | in 37 cases |
| Polyps | in 29 cases |
| Carcinoma | in 25 cases (or 5.7 per cent) |

Three of these cancers were in nullipara. Eighty-eight per cent occurred in women who had been pregnant. Three were in colored women and one in a Jewish woman (1 in 46, or 2.17 per cent). There were no carcinomas in the prolapsed uteri.

*Operations* were performed as follows:

| | |
|---|---|
| Dilatation and curettage | 151 |
| Sturmdorf's operation | 119 |
| Trachelorrhaphy | 105 |
| Amputation of cervix | 39 |
| Biopsy section | 47 |
| Hysterectomy | 62 |

*Summary of Clinical Data:*

In 589 cases from hospitals A, B and C:

| | Per Cent |
|---|---|
| Pain in the lower abdomen occurred as a chief symptom | 49.0 |
| Leucorrhea | 41.6 |
| Menstrual disorders | 35.0 |
| Pain in the back (since last childbirth) | 22.0 |

Groupings of these main symptoms occurred frequently. Each of the foregoing symptoms occurred in higher percentages when recorded not as dominant but as occasional or associated subdominant complaints. For example, leucorrhea is previously mentioned as having prevailed in 88 per cent of all cases.

## TREATMENT

Treatment of cervical pathology has possibilities for success not equaled elsewhere in the body. There is most convincing evidence given by many operators and writers that repair of injuries in the cervix can be done immediately so as to prevent almost all erosions, ulcerations, ectropions and infections.

With repair accomplished and the foregoing changes prevented or cured, there is but little chance, perhaps not more than one in 5000, that malignancy will ever develop. The results accomplished by correct repair appear so certain that even the percentage of cases assigned by inheritance to die do not even develop cancer. If all cervices of patients attended by the medical profession were properly repaired, cancer of the cervix mortality would receive a forced reduction of over 90 per cent.

In the group here studied, 1015 were free from carcinoma, yet approximately 10 per cent or more than 100 gave clinical, gross and microscopical evidence of tendencies

towards malignancy. If prevention can be expected to save 95 to 100 per cent of these cases, what greater field of endeavor is there open in the practice of medicine.

In 3500 sections examined, there were very few tissues removed needlessly. If only the same zeal prevailed for removal of pathological cervical tissues as is practiced upon appendices and tonsils, a most remarkable reduction would follow in the rate of cervical carcinomata.

Our distinguished guest, Professor Adler, of Vienna, has ably presented the successes and failures attained by heroic means of treatment that are limited both in choice of operable cases and in operators of experienced capability.

The workers with *x*-rays and radium have a larger field in case selections and are able to report a better salvage of advanced cases.

With surgery or irradiation uncombined or combined, "80 per cent of all cases seen will fail to survive five years."

The type of pathology under discussion in this paper is highly segregated by the history of pregnancy. The events of pregnancy quite generally permit unhindered prepuerperal and puerperal treatment for infection and repair providing 95 to 100 per cent prevention of cervical carcinoma over (not a five year period) a life time.

## SUMMARY

1. Histopathological studies were made of approximately 3500 sections of 1200 cases from which biopsies were obtained, the material having been selected after certain clinical indications.

2. All sections received a diagnosis following their removal, and certain "follow-up" data have been available.

3. The second review of sections was independent of the first diagnostic work and was completed as a consecutive study following a survey of the literature covering the past six years.

4. Approximately one-third of the biopsy tissue from this series was of little value because of improperly taken sections that omitted stratified epithelium and glandular epithelium. An imaginary hemisected plane should be made of each cervix, and the most fertile pathological half is selected for a section 1.5 cm. long, the upper portion of which is 0.5 cm. within the external os. The tissue selected should present abnormal characteristics to both ocular and palpatory examinations.

5. The examination of a large number of tissues and case histories in sequence afforded standardization values not otherwise obtainable. In this series 186 malignancies occurred and all gradations of tendencies from the normal tissue structure to that of malignancy were observed as oft-repeated pictures.

6. The exceptional opportunity provided by a large number of cervical tissues emphasizes certain very clearly defined principles associated with malignant changes. There is no evidence that mature normal tissues (as judged by the usual histopathological standards) can pass over into a state of malignancy.

7. There was abundant and convincing evidence in this material that the following conditions were essentials of the premalignant and malignant process:

(a) Tissue injury.

(b) Continued unremitting irritation to tissue layers and cells.

(c) Demobilization of tissue and cell relations.

(d) Exposure of immature, incompletely differentiated cells to continued irritation and hyperphysiological stimulation.

(e) Newly produced cells with cessation of maturing ability in form and function beyond that of simple division, and these cells in turn are of less mature appearance.

(f) The progeny of the basal cells in the stratified epithelium when exposed to chronic inflammatory effects delivered from the stromal side, displayed the most frequently produced pictures of the beginnings of malignancy.

8. The clinical symptoms of pain in the lower abdomen, leucorrhea, menstrual disorders and pain in the back prevailed in

from 49 to 22 per cent of the cases in the order named as dominant complaints.

9. Prevention of cervical pathology is a most profitable field of therapeutic endeavor. In cases of laceration, erosion, ectropion, infection, ulceration, early and adequate attention yields almost a perfect score of cures and at the same time prevents cancer formation in from 90 to 100 per cent of cases. The same attention given to the cervix that has been directed to the appendix and the tonsils would secure an astounding change in the cancer statistics of the cervix.

10. The study of cancer is more favorably accomplished in the cervix uteri than in any other tissue of the body; irritating etiologic factors may be followed and tissue change observed at any stage before and during cancer formation. Effects of treatment can be safely studied in biopsied tissues.

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# TUBERCULOSIS OF THE GENITOURINARY TRACT*

CHARLES H. CHETWOOD, M.D., F.A.C.S.

NEW YORK CITY

IN choosing as a leading topic from the domain of the genitourinary system, tuberculosis of those organs, it is, I think, wise to have a paper upon such subject bear a comprehensive title, in order that it may open up an unrestricted discussion embracing the entire field. This is manifest because tuberculosis, not being solely a urological malady, but in point of fact a constitutional invasion, is and always has been extensively written about, intensively studied, given special classification in medical literature, in hospital practice and in municipal public health supervision. All this has tended toward standardization of our knowledge of the subject with the establishment of certain accepted facts which may not at this time bear modification. Thus it would be of doubtful value to consume more space than is necessary to recount some of these generally recognized truths and be of greater interest to invite contribution to the discussion of the still disputed questions. In order to attain this object the whole field must be included. It will be my purpose, therefore, to call attention to some of the moot points in the urological field of tuberculous invasion and to set forth, as well as may be, the pros and cons thereon.

For general consideration, tuberculosis of the genitourinary tract is divided into that of the urinary organs, on the one hand, which embrace the kidneys, ureters and bladder, and on the other, tuberculosis of the genital tract, consisting of the prostate, seminal vesicles and testicles. Tuberculosis of the kidney is by far the most common of these lesions, extension of the disease to the kidney being secondary to a primary focus, pulmonary or gastrointestinal; likewise, involvement of the other urinary and of the genital organs is usually, although not essentially, secondary to that of the kidney.

I will first undertake to present what would seem to be today substantially agreed upon as some of the classical features of tuberculosis of the urinary tract: As to the prevalence of the disease in the urogenital tract, it is generally recognized and recorded that the decline in pulmonary tuberculosis in the last decade is anywhere from 20 to 25 per cent. Hence there is to be expected, and statistics indicate, a relative decrease in involvement of the genitourinary organs. This acceptable abatement in this scourge of civilization is a justification of modern methods of hygiene, and of the emphasis which has been laid on the need for sanitation, intensive diagnostic study, prophylaxis and better living conditions.

The importance of the urogenital tract in any consideration of regional tuberculosis is manifested by the demand for operations upon that tract, as for example, tuberculosis of the kidney. This is stated to comprise, as quoted by V. C. Hunt,[1] 27 per cent of all nephrectomies at the Mayo Clinic for surgical lesions of the kidney. This number represents about 0.5 per cent of all operations performed in a general hospital, and while not revealing the percentage of occurrence of involvement of the urinary organs in cases of pulmonary tuberculosis, it is stated by Kuster as cited by Caulk[2] that 10 per cent of patients dying of tuberculosis have kidney involvement.

A very important consideration in studying this subject is the frequency of bilateral renal involvement. This is of prime significance for it may, or may not, determine the question of the expediency of operation in a case where surgical intervention is palpably indicated.

* From the Department of Urology, French Hospital, New York. Submitted for publication January 6, 1932.

The percentage of bilateral involvement has been variously stated, according to individual experience, approximating 15 to 25 per cent as confirmed by clinical and other diagnostic data. The percentage would be highest when revealed through necropsies, not only because such fatal cases are on balance in a more chronic and advanced stage of the disease, but likewise because the complete investigation, embracing sectioning and cross-sectioning of both kidneys, lessens the chances of overlooking minor lesions. This subject will be further discussed when those questions that may be considered as still debatable and upon which there is not a general concensus of opinion are taken up.

*Etiology.* The etiology of tuberculosis of the genitourinary tract is indisputable, it being secondary to a pre-existent focus elsewhere, usually pulmonary. It is stated that renal tuberculosis is secondary to pulmonary in about 50 per cent of the cases. It would seem that the percentage of such derivation from the pulmonary tract is even greater than this, although the alimentary tract, the mesenteric and other lymph glands and the bones may have an intermediate connection therewith; the blood stream is the medium of communication and the tubercle bacilli the agents of transmission. The question as to whether these agents can enter the blood, then reach the kidneys and pass out of the organism without creating any disturbance in passing, is another subject of debate to be dwelt upon later. It suffices to say here that in some instances the kidney unquestionably becomes the site of tuberculous deposit early in the clinical history of a pulmonary subject; in others, the more chronic the disease, the more threatening it becomes to the genitourinary system, as it also is to other tissues of the body.

It is not necessary to dwell upon the contributing causative agencies in tuberculosis, such as bad hygiene, inherent predisposition or lack of resistance; to these must be added the local elements of causation that may be present in the organs themselves. Of such elements may be mentioned, trauma, pre-existent invasion of other organisms, abnormal functionating efficiency.

*Pathology.* The pathology of urogenital tuberculosis in a broad sense may be stated as presenting itself anywhere from a miliary to a massive involvement, and ranging from an acute to a chronic development.

*Clinical Picture.* The clinical picture of urogenital tuberculosis naturally varies with its location. It is an outstanding fact that tuberculosis of the kidney may continue to an advanced stage before it is detected. This does not apply to acute kidney involvement of the multiple miliary abscess-foci variety, but to chronic tuberculosis of the kidney which progresses slowly, there being a continuous antagonism between the protective agencies of the body and the irritating tuberculous process, a process amounting often to an encapsulation and the establishment of silent encysted areas. These conditions may remain, producing little pain or other disturbance until a coalescence of other abscesses occurs with an extension into the renal pelvis. When the bladder and ureter are subjected to a continuous flow of tuberculous infected urine, there is usually exerted a strong resistance to infection; but the ureter may become a direct extension and a part of the kidney lesion. The bladder mucous membrane resists for a long time, usually becoming involved late in the disease only. Such involvement, revealed by frequency and irritability of urination, in many instances is the first manifestation to attract attention to the urological phase of the disease. Therefore, it may be a matter of years before clinical evidences of urogenital tuberculosis are detected. When the tuberculous process attacks the genital organs, the symptoms will assume a character peculiar to the region involved.

*Diagnosis.* The diagnosis of *urinary* tuberculosis is accomplished by a routine examination embracing the laboratory evidence supplied by functional urinary tests

aided by cystoscopy with ureteral catheterization and pyelography. This investigation should be repeated on different occasions until a final corroborated diagnosis has been reached. In the case of genital tuberculosis, the existence of tuberculosis in other parts of the organism provides a clue. The urinary tract should always be searched for other lesions. Rectal examination is relied upon to detect tuberculous involvement of the prostate and seminal vesicle and the discovery of a pathological infiltration of these organs in association with a tuberculous lesion elsewhere suggests the probable diagnosis.

*Treatment.* The treatment of *genital* tuberculosis when it is localized in the external genitals affords little for special discussion, being governed by general surgical practice, as applied to sinuses, abscess and the radical removal of the involved glandular organ. The question of the treatment of the internal genitals being debatable, is referred to a later section of this paper. The treatment of *urinary* tuberculosis may be summed up in general terms: Nephrectomy should always be resorted to as early as possible for an active tuberculous lesion confined to one kidney. This generally exercises an inhibiting effect upon bladder involvement not too advanced in character, varying in its time of alleviation from a few weeks to many months. In the case of active vesical ulceration or more prolonged inflammation, other local treatment is demanded, such as diathermy and, in advanced cases, fistulous surgery.

## DEBATABLE QUESTIONS REGARDING UROLOGICAL TUBERCULOSIS

While the points concerning tuberculosis of the urogenital tract just enumerated are conceded by most students of the subject, there are a number of questions concerning which there is much difference of opinion. Such pronounced controversy on the part of authorities may well cause those less familiar with the subject great difficulty in judging the merits of any particular case presented, but in many individual cases it is often possible to reconcile such divergent opinions.

The first question of a controversial nature to be considered is:

1. *Can the kidney secrete or excrete tubercle bacilli and itself remain healthy?* That is to say, do tubercle bacilli appear in the urine independent of a renal lesion? Does a healthy kidney excrete microorganisms or harbor them? This question might be answered by the statement that even if the healthy kidney excretes microorganisms of any character, the pathological kidney might harbor them and a previously nontuberculous pathogenic kidney would thus become a tuberculous organ. Wildbolz[3] takes exception to the statement that the finding of tubercle bacilli in the urine is evidence of a caseous tuberculosis of the kidney. He holds that the presence of bacilli in the kidney secretion may be due to "tuberculous bacilluria" which is an excretory action on the part of the kidney seen in patients having pulmonary foci of an advanced nature. This might occur without there being any tuberculous changes in the kidney. In a word, Wildbolz makes the significant statement, which he thinks is indisputable, that tubercle bacilli may pass through the kidney and appear in the urine without demonstrable tuberculous tissue changes and without the presence of pus in the kidney secretion.

On the other hand, the contribution of Bumpus and Thompson[4] in referring to records of the Mayo Clinic up to January, 1929 and stressing "changing conceptions" upon the subject treated "in the decade 1920 to 1930," reaches the conclusion that a normal kidney cannot filter bacteria out of the blood stream into the urine and that the presence of bacilli of tuberculosis in the urine almost always indicates renal involvement.

Medlar[5] reached the same conclusion, viz., that tubercle bacilli are not secreted in the urine without tuberculous lesions being present in the kidney.

Caulk[2] takes issue with the suggestion made by some observers that tubercle bacilli are found in the kidney specimens independent of a renal lesion.

In reviewing this question, one must take the stand that the preponderance of evidence favors the view that tubercle bacilli in the urine indicate the presence of tuberculous lesions in the kidney excreting it. A so-called "tuberculous bacilluria" is believed to exist due to the excretion by the kidney of tubercle bacilli from the blood in patients free from symptoms, but there is not a sound basis for the belief. While the kidney might excrete toxins just as it does chemical agents, without the existence of a lesion, there is not sufficient basis for the claim that the organisms themselves are excreted without the existence of a kidney lesion. Therefore, we must subscribe to the concrete statement that the presence of tubercle bacilli in the urine is positive evidence that one or both kidneys are involved.

The second question upon which there has been controversy and difference among authorities, is: *Can a tuberculous kidney lesion heal spontaneously?*

This question, when put to him by the patient, calls for an answer from the medical practitioner. It is the belief of Harris of Toronto[6] "that minute foci of tuberculosis in the kidney undergo healing just as do tubercles in other tissues." He further states "that there is the fact that early small lesions at least have a strong tendency to heal. The lesion may heal in this early stage so that the patient goes through the whole course of renal tuberculosis without ever presenting symptoms attracting attention to the genitourinary tract." On this point we might emphasize the fact already mentioned, that in the clinical history of renal tuberculosis, months and years may pass before its manifestations attract attention.

Chute[7] thinks that tubercles are brought to the kidney in large numbers from foci located elsewhere but that the generous blood supply of the kidney enables it to overcome most infections while they are still incipient. That the initial lesions of tuberculosis often heal is confirmed by Bumpus and Thompson[4] in reporting their experience with 300 cases of genital tuberculosis.

Braasch[8] of the Mayo Clinic states "we formerly believed that renal tuberculosis never heals spontaneously." Yet he believes that early renal infections of tuberculosis without necrosis or destruction of the kidney substance might permit a spontaneous healing.

Medlar[5] in experimenting upon animals, found scars upon the kidneys which he took to be a "reparative process" and he states that this was confirmed by later experience with human subjects.

Those who hold the opposite view are equally positive that their position is correct.

Maurice Persson[9] states "it has been impossible to demonstrate spontaneous healing of tuberculosis of the kidney in a single case."

Caulk[2] holds in a recent contribution that "the only way in which a kidney may apparently heal is through its seclusion by ureteral stricture with subsequent autonephrectomy and occasionally by localized isolation in certain portions of the kidney."

Wildbolz[3] of Switzerland, much quoted authority, remarked "that if healing of a clinically demonstrable caseous renal tuberculosis ever occurs at all it is certainly extraordinarily rare."

Lowsley and Kirwin[10] in their textbook state that in the early detection and extirpation of the tuberculous process of the kidney "lies the patient's only hope of cure."

On the other side of this question is a case related by Barney[11] of Boston, reliable and conservative observer. This patient was seen by him eight years previously when he diagnosed a right pyonephrosis for which a nephrectomy was refused. Ten months later abscesses formed and opened in the buttocks leaving sinuses. A year later cystoscopy revealed edema of the vesical

neck with pus and tubercle bacilli in the urine from each kidney. The right kidney function was very poor, the left below normal. Pyelograms of each side showed markedly dilated pelves and blunted calices. Under the circumstances of what seemed to be a bilateral involvement, it was not felt that operation of any kind was justifiable. The patient went to Maine, lived out of doors, gained 40 pounds in weight and eight years after the original examination, cystoscopy revealed a perfectly normal bladder and ureters, with normal urine coming in good time from both sides. The pyelogram showed some distortion but little that could be termed abnormal. This history was verified by careful laboratory studies and was reported as a case of healing of tuberculosis without operative interference of any kind.

In the face of this conflicting judgment on both sides of the question, what attitude are we then to assume? It is that truth and reason are to be found on both sides of the question. The rules that apply to a pathogenic process of any kind apply here. A mild process, tuberculous or otherwise, can, under favorable conditions, disappear spontaneously. A tuberculous process is less likely to do so than otherwise.

An abscess is a surgical lesion and as such demands surgical intervention. An organ *greatly* destroyed by a vicious process is better removed than allowed to remain to contaminate further the body organism.

How far a tuberculous process can advance and still undergo a reparative healing process it is impossible to state. We do know that the advantages derived from sunshine, from outdoor air and from good food and hygiene are almost in some instances beyond limits.

3. *In bilateral cases, should the more diseased kidney be operated upon?*

This is another much contested question. In all of the bilateral cases reviewed by Persson[9] which were nephrectomized, the patients died within two years of operation. Nephrotomy and resection uniformly gave bad results. At the Mayo Clinic,[12] 18 cases of bilateral infection were operated upon over a period of nearly a quarter of a century. Of these, 4 patients died immediately after operation and 10 within eighteen months, most of them from renal insufficiency or from the effects of tuberculous processes elsewhere in the body.

Legueu[13] reported 93 cases where a nephrectomy was performed despite the existence of bilateral infection. Of all these patients it was recorded that 13 died from anuria immediately after operation and 30 died during the succeeding three years, leaving hardly more than 5 per cent alive. Many of these were in an advanced stage of tuberculous infection.

Hunt of the Mayo Clinic says:[1] "Nephrectomy in the presence of bilateral renal tuberculosis is seldom indicated or justifiable." He qualifies this, however, by adding that it may occasionally be justly considered if there is much pain, hematuria or acute sepsis in one kidney, and only slight involvement in the other. Wildbolz believes that tuberculosis of the kidney is often diagnosed, when actually it is only the ureter which is involved. If one kidney is proved tuberculous and on the opposite side there are organisms in the ureter which have reached there by bladder reflux, and by proper catheterization the kidney can be proved sound, then the affected kidney should be taken out. "If the remaining kidney is also involved as well as its ureter, nephrectomy on the opposite side is not advisable." The suggestion which has attained considerable popularity of late, that is, that the more damaged kidney should be removed, provided the second kidney has fairly good function, this authority rejects with emphasis. He is positive that healing will never take place spontaneously in a kidney once actually invaded by the tuberculous process, and nephrectomy on one side merely shortens the patient's life.

Kretschmer,[14] on the other hand, said of the 19.3 per cent of his patients who were proved to have bilateral renal tuberculosis that nephrectomy was "the only therapeutic agent at hand" for their relief. Yet

in his published writings he does not often mention having actually operated upon the more diseased organ in bilateral renal tuberculosis. Caulk says that removal of the more diseased of a pair of tuberculous kidneys is "not advisable."

It is not possible in my judgment to lay down a hard and fast rule upon this question; each case must be governed according to its individual peculiarities.

4. *What is the bladder picture in renal tuberculosis?*

There is much difference of opinion as to the condition of the bladder in renal tuberculosis, though at present quite general agreement prevails that the disease is seldom, if ever, primary to the vesical cavity.

Young[15] says positively that the milder degrees of tuberculous cystitis are not of "characteristic appearance." He mentions especially, however, the tendency of inflammation and later, of ulceration, to center about the base of the bladder and the trigone. Even in unilateral renal tuberculosis the bladder lesions may be observed about both ureteral orifices. He mentions that the tags of mucosa and polypoid masses of granulation tissue seen about the ureteral openings in the later stages of kidney infection, often suggest malignancy, and cannot always be diagnosed with accuracy. But in the resumé of diagnostic measures for establishing the existence of renal tuberculosis, which he gives in his "Urology," Young lays very little stress upon the bladder picture.

Braasch and Scholl[16] also mention the possibility of confusing the lesions about the orifice giving access to the infected kidney with vesical neoplasm. In many instances they have seen proliferation of the inflammatory area all across the trigone and even invading the farther portions of the bladder wall. It is apparent that they do not regard the cystoscopic evidence to be valuable unless corroborated by other data.

In contradistinction to this uncertainty in regard to the bladder picture we have the very positive statement of Caulk[2] that "the cystoscopic picture of the bladder is the most definite single finding of urinary tract tuberculosis." He claims that by cystoscopy alone 78 per cent of his renal tuberculosis cases were positively recognized, although many other diagnostic procedures were used as confirmative measures.

I believe that a bladder picture may, and often does, afford *prima facie* evidence of tuberculosis elsewhere in the upper urinary or genital tract; yet corroboration should always be sought for and by persistence will almost always be revealed.

5. *Should genital tuberculosis (referring to the internal organs) be operated upon, and if so, what procedure is to be preferred?*

Ever since Young put forward his radical operation for genital tuberculosis there has been much discussion as to the wisdom of subjecting patients to so mutilating a procedure for the relatively small chance of life and health the operation may afford.

Bumpus and Thompson[4] of the Mayo Clinic do not appear to advocate radical surgical procedures, and the same conservatism is evident in the writings of other workers in this clinic.

Much of the literature on the subject is in favor of the radical treatment because the majority of writers holding opposite opinions are silent inasmuch as they occupy the entrenched position of having nothing better to offer, surgically speaking.

It would seem, to *sum up* the question of treatment of general genital tuberculosis, that if it is possible to obtain hygienic surroundings and out of door treatment, heliopathy, etc., this is the appropriate course to follow in conjunction with such surgical intervention as the activity of an existing localized process may demand. But as stated by Hinman[17] this will also depend somewhat upon the economic situation of the patient and if such conservative course is economically impossible, resort to radical surgery may be the alternative.

I will close this urological contribution with the brief comment upon the general

topic that the result of the humane campaign against tuberculosis is a chronicle of splendid achievement in modern medicine. The credit is due more to the internists than to the specialists in this department, the urologist being only an accessory. The fact which is of most consequence to the branch of the subject to which this paper is devoted is that with the great diminution of general and pulmonary tuberculosis comes also a relative conquest of the disease in its invasion of the urogenital tract.

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# LIPIODOL INJECTION OF BILIARY FISTULAE

## WITH REPORT OF A CASE OF A FOREIGN BODY IN THE GALL BLADDER FOR A PERIOD OF EIGHTEEN YEARS*

HAROLD J. SHELLEY, M.D., F.A.C.S.

NEW YORK

INJECTION of biliary fistulae with radiopaque substances is of particular interest because by this method we are able to visualize the anatomy of the biliary passages in the living human. This is the only practical method we have of studying their anatomy and their pathological processes except by direct examination at the time of the operation. Even this does not show their anatomy in the full detail demonstrated by roentgenograms following the injection of radiopaque substances.

FIG. 1. Cholecystogram of Case 1. A faint outline of gall bladder against liver border is shown.

Determining the cause of the persistence of certain biliary fistulae and finding the location of the obstruction often presents a most difficult problem to the surgeon. Injection of the fistulous tract with a radiopaque substance will ordinarily make the solution of this problem simple. A much more direct attack may then be made upon the seat of the trouble by the surgeon.

### LITERATURE

Visualization of the gall bladder and biliary passages by the injection of radiopaque substances through biliary fistulae has been used rather widely for the past several years to determine the cause of the persistence of these fistulae. Lanari and Squirru[1] in 1924 showed roentgenographs of the biliary passages after lipiodol injections.

Cotte[2] in 1925 demonstrated very clearly the presence of a calculus in the ampulla of Vater by lipiodol injection of a biliary fistula. Gauillard[3] and Ronneaux[4] in 1927 each reported a case of closure of the common duct after cholecystectomy which was relieved by lipiodol injection.

Frazier[5] in 1929 reported the results of experimental work with campiodol (iodized rapeseed oil) as a radiopaque substance. The injection of this material into the biliary passages of one dog gave good visualization and no apparent bad results. This same liquid was used by Overholt[6] for testing the patency or cause of obstruction of the ampulla of Vater by injection through the T-tube inserted into the common duct at the time of operation.

Caeiro,[7] Piccinino and Pazienza,[8] and Ginzburg and Benjamin[9] have reported postoperative studies of the biliary passages. The demonstration in the papers of Cotte,[10] Overholt,[6] and Ginzburg and Benjamin[9] of these passages and of calculi in them is really remarkable.

* Presented before the West End Medical Society, February 28, 1931.

Mallet-Guy, Beaupère and Armanet[11] report the only complication found in the literature. A few hours after injection the patient had abdominal pain, colic, nausea and some shock. However, in this case it was necessary to inject a large amount of the lipiodol under considerable pressure in order to obtain visualization. Overholt[6] reported one reaction of pain, nausea and vomiting. He attributed this not to the campiodol, but to the fact that a clamp had been left for some time on the T-tube with a blocked ampulla of Vater.

A review of the literature on the subject reveals that the commonest cause of persistence of biliary fistulae is obstruction of the common duct and ampulla of Vater. Although the following cases are reported primarily because they show the value of the lipiodol injection of biliary fistulae as an aid in the diagnosis of their cause, they also demonstrate two causes of biliary fistulae other than that given here. In 2 cases intermittent or partial obstruction of the cystic duct was the cause of the fistula and in the other, a foreign body which had been present in the gall bladder for eighteen years without symptoms other than the fistula and that only for the last three years of this period.

Fig. 2. Roentgenogram of Case 1 after lipiodol injection of sinus. The end of the catheter is in the sinus opening. The gall bladder with filling defect, the biliary ducts and some lipiodol in the duodenum can be seen.

Fig. 3. Taken after Fig. 2 (Case 1). The catheter has been withdrawn. The branching of the hepatic duct shows.

## CASE REPORTS

Case 1. Mrs. S. F., a housewife, aged fifty, entered St. Luke's Hospital, October 20, 1930, because of a draining abdominal fistula. Eighteen years previously a cholecystostomy had been done because of cholelithiasis. Eight months later the opening closed and remained closed for fourteen years. For the three years preceding admission it had drained mucus or a green fluid constantly. At times the drainage had been profuse but without pain, nausea or other symptoms. At no time during this period had she lost weight or strength.

*Physical Examination:* The only abnormal finding was a draining biliary fistula in the center of a scar in the right upper quadrant.

FIG. 4. Pathological specimen from Case 1. The gall bladder has been opened. The tissue above is the excised sinus tract and surrounding scar tissue. The tape is shown in the position it held originally in the gall bladder.

When this was injected with lipiodol (Figs. 2 and 3), the biliary passages outlined well and the lipiodol passed readily into the duodenum. A large irregular filling defect showed in the gall bladder. A cholecystogram showed only a very indistinct outline of the gall bladder (Fig. 1). A diagnosis of very irregular calculus in the gall bladder was made from the roentgenograms.

Operation was performed on October 25, 1930, under ether anesthesia.

*Pathological Findings:* There was a healed scar in the wall of the right upper abdomen lateral to the rectus muscle and its sheath. In the center of this was a small fistulous tract discharging bile-stained purulent material. This tract was found to lead into the gall bladder at the top of the fundus where it was adherent to the abdominal wall. The gall bladder was about twice the normal size, grayish blue in color, its walls markedly thickened and the mucosa hypertrophied. A large irregular calculus could be palpated in the gall bladder. Dense fibrous adhesions bound the gall bladder down in its bed in the liver and to all adjacent structures. The cystic and common ducts, the ampulla of Vater and the head of the pancreas were normal to palpation.

FIG. 5. Case 11 after lipiodol injection. The sinus tract and the gall bladder show. The biliary ducts do not fill, which suggests an obstruction of the cystic duct.

*Operative Procedure:* A fusiform incision was made about the old scar and the skin edges about the fistula inverted with two rows of black silk sutures. The entire scar was excised en masse from the abdominal wall. After the adhesions were freed by sharp dissection the gall bladder was removed in the routine manner. All raw surfaces were peritonized and the abdominal wall closed in

layers with a rubber dam drain placed down to the foramen of Winslow.

*Pathological Report by Dr. L. C. Knox:*

*Macroscopical Examination:* The specimen consists of a gall bladder with a sinus tract leading through an area of dense fibrous tissue and fat to the skin surface of the anterior abdominal wall. The gall bladder measures 13 by 9 by 4 cm. and is surrounded by dense fibrous adhesions and fat. Its wall measures 0.7 cm. in thickness. The mucosa shows marked ulceration with hypertrophic changes in the central portion where a tightly rolled piece of gauze measuring 6 by 2.5 by 1.5 cm. lies (Fig. 4).

*Microscopic Examination:* Sections of the wall of the gall bladder show a chronic productive and exudative inflammation with marked thickening of the coats and fairly good preservation of the epithelium. There are large numbers of eosinophiles as well as lymphocytes and plasma cells in the mucosa. The muscle coat is hypertrophic and invaded by old scar tissue. Outside of the muscle is also a dense mass of fibrous tissue. The arteries are much thickened by a chronic productive endarteritis.

*Diagnosis:* Chronic productive cholecystitis with sinus tract.

Convalescence was uneventful. A very firm scar resulted with no sinus or fistula. Up to the time when last seen in May, 1931, she had had no symptoms of any kind.

Case II. Mrs. M. McD., a housewife, aged forty-six, entered St. Luke's Hospital, September 27, 1930, because of severe abdominal pain with nausea and vomiting of two days' duration. She gave a history of previous milder attacks of pain in the right upper quadrant. Examination revealed an acutely ill white woman suffering severe pain. The abdomen was distended and generally tender and rigid, the rigidity most marked in the right upper abdomen. The rectal temperature was 103°F. and the white blood count 28,000 with 94 per cent polymorphonuclear leucocytes and 6 per cent lymphocytes. A diagnosis of acute cholecystitis and pancreatitis was made and operation done at once under ether anesthesia.

The peritoneal cavity contained a considerable amount of "beef-juice" fluid, although no areas of fat necrosis were noted. The gall bladder was about three times the normal size and acutely inflamed. The pancreas was thickened and hard. Since the patient was extremely ill no attempt was made to do more than a cholecystostomy and insert two rubber dam drains, one into the lesser omental cavity and the other into the right lumbar gutter.

Fig. 6. Lateral view of Case II. Note the cone-shaped filling defect in the lipiodol at the beginning of the cystic duct. Attempt to do a cholecystogram showed no dye in the gall bladder.

After the operation the patient improved rapidly and was able to leave the hospital on October 28, 1930, with a fistula draining a small amount of mucus and bile. She was given two months in which to recuperate before the second operation. During this entire time the fistula drained mucus and pus and at times some bile. She had a continuous pain beneath the right costal margin associated with backache and pain in the right shoulder.

On December 30, 1930, she reentered the hospital. The gall bladder did not fill when an attempt was made to do a cholecystogram. Lipiodol injection of the fistula (Figs. 5 and 6) showed that it connected with the gall bladder. The lipiodol did not pass from the gall bladder into the biliary passages. The lateral view showed a filling defect shaped like an inverted cone at the ampulla which was interpreted

as being caused by a stone blocking the entrance to the cystic duct.

On January 3, 1931, under ether anesthesia the fistulous tract and the gall bladder were removed. The specimen with the stone in situ in the ampulla of the gall bladder is shown in Figure 7. She made an uneventful recovery and up to the time when last seen in May, 1931, had had no symptoms of any kind. The scar was firm with no sinus or fistula present.

Fig. 7. Pathological specimen from Case II. The tissue above is the excised sinus tract and surrounding scar tissue. The stone is shown in the position it originally held in the ampulla of the gall bladder and corresponds to the filling defect in Fig. 6. The opening of the fistula can be seen in the fundus of the gall bladder.

Case III. F. P., a negro porter, aged sixty-five, entered St. Luke's Hospital, September 3, 1930, because of severe pain in the right lower quadrant. Five weeks before admission he had had a severe attack of generalized abdominal pain associated with nausea and vomiting. From that time he had intermittent attacks of pain across the lower abdomen. On the day of admission he again had a severe attack of generalized abdominal pain which localized in the right lower quadrant. Associated with this were severe nausea and vomiting.

Fig. 8. Roentgenogram of Case III after lipiodol was injected into the fistula opening in the scar of the McBurney's incision. The tract leads into the gall bladder but the cystic and common ducts do not fill. The gall bladder showed no dye when an attempt was made to do a cholecystogram.

His temperature was 101.6°F., pulse 96, and respirations 22. The blood count was: White blood cells 28,000, polymorphonuclear leucocytes 88 and lymphocytes 12 per cent. The urine was negative.

Examination was that of a fairly well nourished elderly negro man who appeared acutely ill. The right lower quadrant was exquisitely tender to pressure and an orange-sized mass could be felt beneath McBurney's point. A diagnosis was made of appendicitis with perforation and abscess formation. Operation was done at once under ether anesthesia.

The abdomen was opened through a McBurney incision and an abscess containing about 8 or 10 oz. of thick pus was found about the cecum. The appendix was involved only in that it made up a part of the abscess wall. Because of the patient's age no further exploration was done. The appendix was removed and the wound closed with a soft rubber dam drain to the abscess cavity. At this time several small black granules were noted on the gauze packs which had been used. They had a somewhat crystalline appearance.

The postoperative diagnosis was abdominal abscess probably arising from an undiscovered perforation in the cecum or ascending colon.

Convalescence was quite uneventful. Purulent drainage was profuse for the first three days when it became very definitely bile-stained. A small amount of this same material continued to drain up to May, 1931. Lipiodol injection of the fistula (Fig. 8) showed that it communicated with the gall bladder but no lipiodol showed in the biliary passages or duodenum. The gall bladder was not visualized when an attempt was made to do a cholecystogram. These findings indicated an intermittent or partial obstruction of the ampulla or cystic duct.

Evidently this patient had had an acute attach of cholecystitis with perforation. As he was up and about a part of the time, an abscess formed in the region of the cecum due to gravity. The fine crystalline particles found in the contents of the abscess were undoubtedly small gallstones.

When the patient was seen in June, 1931, the fistula had been completely closed for two weeks and he had had no symptoms of any kind. Because of this fact together with his age and poor physical condition, cholecystectomy has been deferred indefinitely but will be done should he begin to have trouble.

## DISCUSSION

The preservation of the structure of the gauze in the first case was really quite remarkable. It was stained yellow and felt stony although the roentgenograms failed to demonstrate the presence of calcium salts. No evidence of carcinomatous change could be found notwithstanding the eighteen years of chronic irritation.

The absence of pain or other symptoms was not surprising in that drainage either through the cystic duct or the sinus tract was evidently at all times adequate. The presence of a large gallstone may be asymptomatic in the absence of infection, blocking of a duct or movement of the stone.

The opening of the sinus tract after remaining closed for fourteen years was possibly caused by the ampulla or cystic duct becoming blocked temporarily with pus and mucus. At the time the patient came into the hospital there was sufficient space for the passage of bile and lipiodol beside the tape and through the cystic duct.

The length of the cystic duct as shown in the roentgenograms of Case 1 appears much greater than one would estimate the average length, although at the time of operation it appeared to be no longer than those routinely found.

These cases demonstrate two causes for the persistence of biliary fistula other than the more common cause: closure of the common duct or ampulla of Vater. One is the presence of a foreign body in the gall bladder and the other partial or intermittent closure of the cystic duct. The opening in the gall bladder was made at operation in 2 cases and the perforation was spontaneous in the other.

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[For remainder of References see p. 58.]

# A SPECIFIC TECHNIQUE FOR THE TREATMENT OF ACUTE PERFORATED APPENDICITIS*

FRASER B. GURD, M.D., F.A.C.S.

MONTREAL, CANADA

IT is customary to subdivide cases of acute perforated appendicitis into three groups and to recommend somewhat different forms of treatment for each. Classified, the three types of the disease coming under this heading are as follows:

1. Perforation of the appendix with localized abscess formation.

In this connection the author does not believe it is of very great importance whether abscess formation occurs as a result of actual perforation of the appendix or whether infection of the periappendiceal tissue has taken place through the intact wall.

2. Diffuse spreading peritonitis.

3. Gangrene of the appendix.

In this contribution the author will not attempt to differentiate these three classes but purposes recommending a method of treatment which he believes has proved itself to possess advantages as compared with other methods commonly employed.

There is no need to stress, in this contribution, the importance of an early diagnosis or the necessity for instruction, of both the laity and the practitioners of medicine, with reference to the danger that may accompany the administration of a purgative to the patient suffering from appendicitis. The danger of the latter procedure and the imperative necessity of the former have been, so frequently and so vigorously, urged in numerous articles that it is believed a further reference to these aspects of the subject is unnecessary here.

The author is of the opinion that several doctrines with reference to the operative treatment of acute appendicitis deserve condemnation. In this respect the following are under consideration:

1. The teaching that the risk to the patient may sometimes be minimized by postponement of operation in the hope that a safe period may develop.

2. The teaching that it is a proper procedure to incise the abdomen, evacuate inflammatory material and to leave the removal of the appendix to a later date.

3. The statement that the peritoneal cavity cannot be drained and that in consequence it is useless or harmful to introduce foreign substances into the abdomen in the neighborhood of the appendiceal bed with this end in view.

4. The teaching that if drainage of the peritoneal cavity be not attempted there is less likelihood of a severe infection of the abdominal wall.

5. The employment of firm substances, such as rubber tubes or glass drains for the purpose of evacuation of secretions from the abdominal cavity.

6. The opinion, as exemplified in practice by many surgeons, that adequate exposure can only be obtained by the use of an incision through or alongside of the rectus muscle.

All surgeons will, I believe, agree that all cases of acute appendicitis, seen within the first twenty-four to thirty-six hours following the onset of the disease, require prompt or immediate treatment unless the attack is manifestly mild. Such immediate operation constitutes the most certain prophylactic in avoiding perforation.

In cases seen later than thirty-six hours after the onset of the disease it is usually possible to determine whether operation must be carried out immediately, that is to say with only such delay as is necessary for the exhibition of resuscitative measures

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such as the administration of subcutaneous salt solution and intravenous nutritive (glucose) salines, or whether operation may be properly postponed until a more convenient time, or until more adequate hospital facilities become available.

Although the author is not of the opinion that postponement of operation in cases of definitely walled-off abscesses is likely to improve the resistance of the patient to the infection and so diminish risks of operation, it is at the same time, I believe, reasonable to argue that hasty preparation and midnight operations in such cases may be harmful.

The author recently published an article[1] in which was recommended a definite technique which he believes has proved its value in the prevention of wound infection in cases of acute perforated appendicitis. In the former contribution, the consideration of the more general aspects of the treatment of acute perforated appendicitis was purposely omitted. In the article referred to, proof was offered that by the employment of the technique recommended, wound infection with consequent prolongation of active treatment and necrosis of the abdominal wall can be eliminated. Tables attached to the article referred to showed that not only does there appear to be a very definite shortening of hospital days when this technique is employed, but also that cases treated by the author's method appear to have exhibited a lessened mortality rate.

Since certain procedures appear to have demonstrated their value, both in so far as the mortality from the disease is concerned, and with reference to the shortening of morbidity as well as the avoidance of postoperative hernia, this further contribution is made. In all cases in which the diagnosis of acute appendicitis has been made, and a presumptive diagnosis of contamination of the abdominal cavity in the neighborhood of the appendix arrived at, the following technique is employed.

As a routine procedure, subcutaneous saline (Ringer's solution) is run into the submammary regions during the period that the patient is in the operating room. In this way from 750 c.c. to 2 liters of fluid are introduced. As an anesthetic the author prefers nitrous oxide and oxygen, reinforced with novocaine nerve blocking and infiltration (recently avertin has been used with, I believe, favorable results), for all patients in whom it is believed that a risk of loss of life exists.

The vertical incision through, or alongside of, the rectus muscle is accompanied so frequently by untoward sequelae, that it should not, I believe, be employed in septic cases. At the same time the McBurney incision does not permit of sufficiently easy enlargement to make it useful in difficult cases. For years I have employed a modification of the incisions with which the names of G. G. Davis and Rockey are associated. The essential feature of this incision is that it cuts transversely the superficial tissues, splits in the direction of its fibers the aponeurosis of the external oblique, and enters the abdomen by splitting transversely both the anterior and posterior sheaths of the rectus muscle. The muscle itself is displaced toward the midline, care being taken to displace the vessels and nerves which are found upon the anterior surface of the posterior sheath of the rectus. If this incision be so placed that its medial border is approximately 2 to 3 cm. below the umbilicus and its lateral border 3 to 4 cm. above the anterior superior spine, it is a simple matter to enlarge the incision into the loin by splitting the two oblique muscles in the direction of their fibers. In this way an opening is obtained which will make it possible to deal with any complication in the neighborhood of the cecum and at the same time produces an incision which hardly requires suturing for its closure.

In order that infection of the abdominal wall may be prevented, the whole surface of the wound, following exposure of the peritoneum but prior to its incision, is dehydrated with alcohol, dried and bipp rubbed into the surface.[2] In this way

subcutaneous tissue, fascial layers and the muscle surfaces are covered with a layer of liquid paraffin, bismuth and iodoform which will prevent contamination of the tissues by the infected material, which it is expected will be found when the abdomen is opened.

If the incision recommended be employed it will be found that the opening of the peritoneum through the posterior sheath of the rectus will almost invariably expose the caput of the cecum a few centimeters distal to its commencement. The author has made it a practice to pack off the small bowel from the neighborhood by means of small moist sponges. The cecum is then drawn up into the wound and the field visually and manually explored. If free fluid is discovered this is removed by means of suction and, in so far as possible, swabbing with sponges is avoided.

If, as is so frequently noted, in the type of case under consideration, the cecum cannot be drawn into the wound owing to fresh adhesions and edema of the mesentery, the index finger is employed to discover the line of cleavage which will permit exposure of the appendix or the periappendiceal abscess. As a rule no great force need be employed to open up the diseased area. At the same time the author is very firmly of the opinion that it is of the utmost necessity that the appendix be discovered and removed, at least in so far as its proximal portion is concerned. A suction apparatus must be available at the moment at which the exudate about the appendix is freed in order that diffuse soiling of the peritoneal cavity may be avoided.

Although unfortunately very late cases of generalized peritonitis with multiple walled-off foci of infection are still occasionally seen, the author is of the opinion that the most dangerous type of appendicitis is that of the gangrenous appendix situated in the medial side of the cecum, and so underlying the mesentery to the terminal ileum. In these cases extension of the anaerobic infection to the mesentery is prone to occur with the possibility, or even likelihood, of thrombosis of the veins in the neighborhood.

A similar effect is produced, as has recently been noted by Deaver, when, with the appendix below or medial to the cecum, the engorged mesentery has become fixed not only to the appendix itself but has become constricted, and has possibly initiated gangrenous changes in the terminal ileum. The author has not personally employed the operation of entero-cecostomy as recommended by Deaver in such cases, but is of the opinion that in the unusual case which might prove fatal in consequence of obstruction, the procedure has much to recommend it. It may be pointed out, however, that with the technique recommended in this paper the area of most active disease is so easily opened up for investigation and, if judged advisable, the institution of a cecostomy or enterostomy carried out, that the addition of any plastic operation upon the bowel seems hardly called for.

As the author has already stressed, it is his opinion that the risk of life to the individual is increased if the appendix be not removed. Every effort must be made to discover the point of origin of the appendix on the surface of the cecum. This should be tied off and as much of the appendix as is recognizable removed. Since, in these cases, contamination of the intra-abdominal field has already taken place and the abdominal wall has been protected, it is not of the utmost importance that the appendix be removed in one piece; nor is it, perhaps, of prime importance that the distal extremity of the organ be identified. In as much as the cecal wall itself is usually edematous, in perforated cases, and consequently friable, it is, as a rule, inadvisable to attempt to bury the stump of the appendix. My experience has been that fecal fistulae do not develop in consequence of failure to carry out this procedure, since in no case during the five years under review has a fecal fistula been seen among the author's cases. For the actual removal of the appendix, particularly in retrocecal

cases, the surgeon must approach the task with considerable boldness. The technique named by Crile "the robin method," whereby the submucosa and mucosa are withdrawn from their confining wall, is sometimes of value.

The appendix having been removed and the stump ligated, the field of operation is cleansed by means of the suction apparatus and by gentle sponging. It is unusual to find that it has been necessary to invade the general peritoneal cavity to any considerable extent in order to carry out the necessary interference. Should bleeding be copious, it is advisable to pack the field with hot saline sponges for a few minutes in order to give an opportunity for blood coagulation in the torn vessels to take place. Since packing is to be resorted to in any event, it is not necessary to obtain complete hemostasis.

Whenever there is the slightest suspicion that necrotic material either has been left or may develop, that bleeding is likely to take place or, whenever it is to be expected that an exudate will be required on the part of the tissues to overcome infection, the author prefers to drain the cavity. For this purpose soft packing gauze, 2 in. in width, is employed. This is soaked in liquid paraffin and a small amount of bipp is rubbed on the surface of the gauze. The folded gauze is then packed down into the bed from which the appendix has been removed and withdrawn from the lateral border of the wound. The amount of fluid which pours out on to the dressings in even the most harmless appearing type of case, is sufficient, I believe, to convince the observer that less intoxication of the individual is likely to occur if an opportunity be given for the evacuation of this material, than if it be left to the tissues to bring about its absorption.

The examination of smears from the exudate obtained from the peritoneal cavity may form a reasonable basis upon which to rest a decision as to whether to drain or not; the author, however, is convinced that all parties interested, nursing sister, hospital interne, attending surgeon and patient, will have a better night following operation if the rule be followed to drain all cases in which the slightest excuse for doing so is present.

In the more severe type of case, whether in consequence of diffusion of the general peritoneal involvement or the presence of a large area of edematous tissue, such as occurs in walled-off processes and more particularly in case of anaerobic infection of the tissues in the neighborhood of the gangrenous organ, it is the author's practice to place in the abdominal cavity a very large quantity of liquid paraffined gauze and as much bipp as is thought safe.*

The infected field, more especially the retrocecal tissues, the lower border of the caput and the right side of the pelvis, may be firmly packed with 2 in. or 4 in. gauze soaked in liquid paraffin and to which bipp is added. As a rule three or four large packs are introduced in this way in different directions. It is of the utmost importance that they should be firmly introduced into all interstices of the tissues. The doubled ends are then drawn into the wound and will be found to adequately close the opening in the abdominal wall. Two or three silkworm gut sutures should approximate the skin edges, more or less, in order that the packs may not be extruded. No sutures are introduced into the peritoneum, muscle or fascial layers.

The massive packs introduced into the severe types of cases are allowed to remain undisturbed for a period of from four to ten days, at the end of which time the patient is again anesthetised, the packs carefully removed and the field examined. When the retaining skin sutures are removed, the wound opened and the packs removed, the surface of the muscles, the peritoneum and the exposed bowel are found to be covered with firm, deep red granulations. If packing has been accurately carried out in the first place, no

* Not more, I believe, than a mass equal to approximately one dessertspoonful should be employed.

purulent material will be found present and only unusually will small patches of necrotic material be found adherent to omental tissue or fascial edges.

Any sloughing material is removed, in so far as possible, without the use of cutting instruments and the abdominal wall closed in layers after the whole field has been carefully bipped following dehydration. If any considerable dead space appears to persist following the removal of the pack, or if further necrosis seems inevitable, a small liquid paraffin bipped gauze wick is again inserted.

prevents the development of interstitial tension, the sutures which approximate the skin edges and subcutaneous tissue should not be removed for twelve days following their introduction.

During a period of five years commencing during 1924, the author was in charge of the surgical service of the Western Division of the Montreal General Hospital. For the purpose of this contribution, the cases of acute appendicitis admitted to this hospital during four years, 1925 to 1928 inclusive, have been analyzed. During this period 471 patients having acute appendicitis

Table I
CASES OF ACUTE APPENDICITIS TREATED ON AUTHOR'S SERVICE

| Total No. of Cases | Non-perforated | Deaths | Average Days in Hospital | Perforated | Deaths | Percentage Mortality Perforated Cases | Average Days in Hospital |
|---|---|---|---|---|---|---|---|
| 248 | 170 | 0 | 11.95 | 78 | 3 | 3.84 | 17.02* |

* Excluding fatal cases but including 1 case in hospital fifty days.

Table II
CASES OF ACUTE APPENDICITIS IN SECOND GROUP

| Total No. of Cases | Non-perforated | Deaths | Average Days in Hospital | Perforated | Deaths | Percentage Mortality Perforated Cases | Average Days in Hospital |
|---|---|---|---|---|---|---|---|
| 223 | 169 | 0 | 13.50 | 54 | 10 | 18.51 | 26.80* |

* Excluding fatal cases.

The small pack or wick thus introduced is withdrawn at the end of seventy-two hours. A somewhat copious serous or seropurulent discharge may be poured out between the skin sutures. The latter should not, however, be removed on this account. Since at least one advantage of the mixture of liquid paraffin, bismuth and iodoform, which is known as bismuth iodoform paraffin paste (B.I.P.P.)[4] is due to the fact that its presence over the surface of the tissues delays healing and so permits the evacuation of exudate from the depths of the tissues and consequently

were operated upon in the hospital. Of this number 248, or slightly more than half, were under his personal care or that of his associate, Dr. George D. Little. The patients in this group, Table I, were all treated by the technique referred to in this article. The patients in the second group, Table II, were all treated by surgeons of experience and constitute, I believe, an approximately similar variety of cases.

It will be noted that among cases in which perforation had not occurred prior to operation, the mortality was nil and

the number of hospital days approximately the same in the two groups, slightly under twelve days in the author's group and somewhat over thirteen in the second group. In the perforated cases the differences are, however, striking. In the author's group a mortality rate of less than 4 per cent was attained, whereas in the second group, the mortality rate was over 18 per cent. At the same time, the average days in hospital in the author's series was seventeen, whereas cases in the second group remained in hospital approximately a 50 per cent longer time, that is almost twenty-seven days.

In the author's own group of 78 cases of perforated appendicitis, all of which were treated in the manner recommended in this paper, no case of fecal fistula developed, and in no case was there evidence of spreading cellulitis of the abdominal wall or necrosis of fascia. The author has not seen a case of postoperative hernia or abdominal wall protrusion in any patient operated upon by him or his personal associates during the past ten years, nor has he had such an incident reported to him.

During the past ten years the author has employed a definite group of procedures in the postoperative treatment of all abdominal cases. This method has been altered only in individual cases in which the gravity of the patient's condition seemed to indicate the employment of more rigorous measures. There is an absolute prohibition of everything by mouth during the first twenty-four hours following operation. The patient (adult) receives, per rectum, immediately upon return from the operating room, one pint (20 oz.) of 1 per cent sodium bicarbonate in water. This dose is repeated three-hourly for four doses. Thereafter the patient receives, per rectum, 20 oz. of 2.5 per cent glucose in half normal salt solution every four hours. For thirst the patient receives 20 oz. of tap water, per rectum, as required. In the hot summer weather 6 or 8 pints of water are frequently administered in this way.

If the fluid is run into the rectum at such a rate that approximately twenty minutes are required for the introduction of 20 oz. it is unusual for the patient to be unable to retain the necessary amount. The usual explanation for the report being made that the patient is unable to retain the fluid is the necessity for an enema.

I have always allowed my patients to receive a sufficient amount of morphine or pantopon to ensure rest. As a rule no enema is employed in less than twenty-four hours from the time of operation. The relative absence of "gas pains" with such a technique is proof, I believe, that these pains are in fact due rather to peristaltic effort on the part of the irritated bowel than actually to the presence of gas in abnormal quantities.

During the second twenty-four hours following operation the patient is allowed, by mouth, water, ginger ale, orange and lemon juice, sweetened to taste with glucose, and not with cane sugar. If such a procedure has been followed, the usual less important type of case, such as simple appendectomy or herniotomy, is prepared for a solid diet after forty-eight hours. It is unusual, in my experience, to have vomiting exhibited, irrespective of what type of anesthesia has been employed.

Patients who are more gravely ill, such as many of the cases under discussion in this contribution, receive, in addition, intravenous glucose saline solutions, 5 or 10 per cent glucose in normal saline. As a rule, two or three doses of 750 c.c. each. in each twenty-four hour period, are so administered. The author has never been impressed with the value of stimulants, such as strychnine, camphor or caffeine. Patients who appear to be *in extremis* receive in their intravenous glucose solution from 8 to 15 minims of adrenalin. After the first twenty-four hours, if the patient's condition continues to appear dangerously grave, 0.5 c.c. of pituitrin is administered hypodermically every four hours, although the author is by no means convinced of the usefulness of this preparation.

SUMMARY

In no case of acute appendicitis accompanied by peritonitis, abscess formation, or gangrene, should operation be postponed in the hope that a more suitable period for operation may be arrived at. Supportive treatment can be equally well carried out, after the major focus of infection has been eliminated and after an opportunity has been given for evacuation of toxic material.

By means of a transverse incision placed above the anterior superior spine, adequate exposure can be obtained without the risk of injuring the musculature or nerve supply of the abdominal wall.

If prior to incision of the peritoneum the wound in the abdominal wall be properly prepared and bipped, ultimate infection of the wound can be avoided.

In every case the appendix should be removed, or at least that part of it attached to the cecum, and the stump ligated. As a rule it is advisable to attempt to bury the stump.

In all severe cases, particularly those in which gangrene is present or in which the patient's life appears to be in jeopardy, a technique whereby the abdominal wound is left unsutured and the whole area involved in the inflammatory process packed with liquid paraffined gauze to which bipp has been added, has in the author's hands appeared to be followed by a distinct lessening in the mortality rate. Later closure of such wounds should be accomplished after four to ten days by delayed primary, or by secondary, suture, with the return of the abdominal wall to normal.

The technique described in this article has appeared to lessen the number of deaths, has cut, by at least one-third, the number of hospital days required for treatment and has eliminated the accidental development of fecal fistulae and of postoperative herniae.

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*Continued from p. 51.

# RELATIONS BETWEEN APPENDICITIS & PYELITIS*

JOSEPH K. NARAT, M.D.

CHICAGO

IN discussing differential diagnosis of appendicitis it is customary to mention kidney stones which may cause a renal colic and be mistaken for an acute inflammatory condition of the appendix; some authors also state that Dietl's crises, caused by floating kidney, may simulate appendicitis; relatively few writers however mention the simultaneous occurrence of pyelitis and appendicitis and discuss the pathogenesis of these conditions. The importance of early recognition of the true nature of these cases is obvious because the overlooking of an acute fulminating appendicitis may have grave consequences and even cause a fatal outcome. The presence of pyuria may induce the physician to attribute all the symptoms to a pyelitis and to refrain from a life-saving operation. The following case illustrates the difficulties of the diagnosis:

Mr. N. K., twenty-three years of age, was referred to the author and admitted to the Lutheran Memorial Hospital, September 21, 1931, record no. 20154, with complaints of vomiting and pain in the right lower quadrant of the abdomen. According to the patient's statement, the pain started thirty-six hours previous to admission to the hospital. The pain was localized in the umbilical region and was severe at first; it gradually became dull and aching in character and shifted to the right lower quadrant and to the right loin. The patient also complained of dysuria, preceded by frequent micturition.

*Past History:* Circumcision in infancy; measles at the age of eight; tonsillectomy at the age of twelve. Venereal diseases denied. Family history of no importance.

The *physical examination* gave negative findings with the exception of the abdomen which was rigid on both sides, tender and moderately distended; there was also tenderness on deep pressure in the right flank. The Rovsing's sign was positive, i.e. pain was experienced in the appendix region after deep pressure has been applied and suddenly relieved in the region of the sigmoid. The temperature was 99.8°F. and the pulse 76. The patient's tongue was moist and coated.

A catheterized specimen of *urine* was obtained; the urine had a cloudy appearance and a deep yellow color; the reaction was acid; the specific gravity was 1030; albumin and sugar were absent; leucocytes were present in great numbers; they were forming clusters; there was a considerable number of epithelial cells and shreds of mucus. The benzidin test was negative; there were few granular casts.

The *blood* examination gave the following results: 4,650,000 red blood corpuscles; 18,700 leucocytes; polymorphonuclear neutrophiles 83; small lymphocytes 9; large lymphocytes 3; large mononuclears 3; transitional 2; hemoglobin 85 per cent.

In view of the fact that the rigidity and tenderness were not confined to the right lower quadrant but were also present in the left lower quadrant and in view of the positive Rovsing's sign it was concluded that an acute appendicitis must be present and that the pyelitis was of a secondary nature.

An *operation* was performed and an acutely inflamed appendix found in the lumbar region, ascending on the lateral side of the cecum; a small amount of serous exudate was present in the peritoneal cavity. Appendectomy was performed.

Gross description of the specimen was as follows: appendix 7 cm. long, green-red in color; the lumen dilated and filled with pus. Under microscopic examination, the mucosa and muscularis were found to be covered by and filled with polymorphonuclear leucocytes. The pathological diagnosis was suppurative appendicitis.

The patient made an uneventful recovery and the urine cleared up within ten days spontaneously, without any medication.

* Submitted for publication November 12, 1931.

In this case evidently the appendicitis caused a secondary infection of the renal pelvis or ureter; this condition cleared up after removal of the primary focus of infection, due to rest in bed and a bland diet.

The pain in the right flank and the urinary findings were justifying the diagnosis of pyelitis and appendicitis would have been excluded if it were not for the tenderness in the left lower quadrant and the positive Rovsing's sign; both symptoms are not present in pyelitis.

The following case is more interesting because the infection apparently spread in the opposite direction, i.e. the appendicitis formed a complication of pyelitis.

V. S., a girl six years of age, was first seen by the author July 30, 1931. The mother stated that the child had been sick for the last three weeks but she was up and around most of the time. At the onset of the disease the child had a skin eruption diagnosed by a physician as chicken-pox, and shortly afterwards she began coughing; another physician at that time diagnosed whooping cough. One week before the examination by the author, the girl began complaining of pain in the right kidney region and was taken severely ill. She vomited once during the onset of the pain; ever since then she had been confined to bed.

*Past Medical History:* scarlet fever, measles. Surgical history: tonsillectomy at the age of four; drainage of an abscess of the right leg after scarlet fever at the age of five. The family history did not present anything of importance.

At the *physical examination* it was found that the child was considerably undernourished. There were no râles or dullness over the lungs. There was a distinct systolic murmur over the mitral area; the second pulmonary tone was accentuated. There was a pronounced tenderness in the right kidney region and the patient pointed to the right flank as to the place of greatest pain. The abdomen was soft, not painful even at deep pressure and not distended. The mother stated that the child was constipated. The skin showed numerous marks of former pustulae, possibly originating from chicken-pox. The glandular and neuromuscular systems, bones and joints gave negative findings. The temperature was 102°F., pulse 120, respiration 18.

The *urine* examination gave the following findings: appearance cloudy, color yellow, reaction acid, specific gravity 1.015, albumin +, sugar absent, casts absent, many epithelial cells, very many pus cells, few erythrocytes, few urates.

Rest in bed, liquid diet and alkalies were prescribed. Four days later the child was brought again to the office and being severely ill was immediately sent to the St. Elizabeth Hospital, where she was admitted August 3, 1931, case no. 2257.

Now the clinical findings were entirely different; although there still was tenderness in the right flank, the child complained of severe pain in the appendix region; the abdomen was rigid on both sides, especially in the lower half, and tender to touch. The child was coughing and a few moist râles were heard over both lungs posteriorly.

The *x*-ray report was as follows: "The film made of the chest shows a slight congestion of the right lung, a slight degree of pleural thickening and swollen hilum glands as well as an increase in peribronchial fibrosis. These findings could result from any acute systemic inflammatory process. There is no evidence of any definite pulmonary pathology at this time."

*Urinary* findings were as follows: cloudy appearance, straw color, acid reaction, trace of albumin, no sugar; specific gravity 1.010; casts absent; some epithelial cells; very many pus cells, forming clusters; very many red blood corpuscles; few urates.

The *blood* examination gave the following result: red blood corpuscles 4,360,000; hemoglobin 65 per cent; leucocytes 28,300; polymorphonuclears 77, eosinophiles 1, basophiles 1, lymphocytes 21.

The diagnosis of pyelitis with secondary appendicitis was made and the child was operated on the day of admission. A serous exudate was found in the peritoneal cavity; the appendix was acutely inflamed. An appendectomy was performed. After the operation the temperature of the child ranged between 100°F. and 104°F. for eight days. Afterwards the temperature gradually subsided and the child made an uneventful recovery. The urine examination eight days after the operation gave approximately the same findings as

before the operation, but red blood corpuscles were absent. Three weeks after the discharge from the hospital the urine was free from pus and the child was in an excellent physical condition.

In this case the pyelitis probably developed as a sequel of whooping cough or chicken-pox. As the sickness began with pyuria and pain in the right kidney region without any apparent involvement of the intraperitoneal organs and the symptoms of appendicitis appeared a few days later, we are justified to make the conclusion that probably the appendicitis developed following pyelitis. Pyelograms were not made in either of these cases because the severe acute illness made such a procedure not advisable. Intravenous injection of iothion was also given up for the same reason.

Maloney and Cracco[1] made a survey of 7300 operations performed in the Woman's Hospital of New York; complications of pyelitis were found in 24 cases, 0.33 per cent. In their opinion trauma and shock of operation lower the resistance of the patient and foci of infection which would be held in control under normal conditions, would now have opportunity of starting lesions in various regions of the body, especially in the kidneys. M. Thompson[2] found among 200 cases of acute appendicitis 3 cases associated with pyuria. The author believes that the pyuria is due to a secondary inflammation of the portion of the ureter adjacent to the appendix. Van Duzen[3] found among 300 cases of pyelitis 23 cases, 7.6 per cent, due to appendicitis. He states that he frequently sees cases of retrocecal appendicitis with pain along the course of the ureter, urinary frequency and hematuria. Hunner[4] described a case of acute pyelitis due to acute appendicitis. Rosenkranz[5] reports a case of perityphlitic abscess followed by pyelitis. Proust[6] observed chronic pyelonephritis with acute exacerbation in the course of chronic appendicitis, cured by operation. Franke[7] discusses the various possible paths through which the infection may spread from the appendix to the renal pelvis. In his opinion three ways are possible: 1, hematogenous; 2, ascending; 3, lymphatic. Petruschky[8] and Pilcher[9] expressed the opinion that lymphatics must exist between the ascending colon and the right kidney. Stahr[10] showed that the lymphatic vessels of the kidney anastomose with the lymphatic vessels of the renal capsule and that lymphatic vessels from the lateral wall of the cecum and ascending colon can be traced to the retroperitoneal space, running from there over the capsule of the right kidney to the lumbar plexus. This author injected the lymph vessels according to Gerota's method and succeeded in demonstrating communications between the appendix and right kidney. He states that on the left side no parietal paths could be found but he assumes that the mesenteric path probably communicates with the left kidney. This author claims that the lymphatic stream has the direction from the intestines to the kidneys. Artificially created constipation in rabbits caused colon bacilli to enter the lymphatic vessels from the intestines. This experiment shows that intestinal stasis may cause a bacteriemia of the lymphatic vessels and a secondary infection to the renal pelvis.

One occasionally sees acute appendicitis accompanied by pus, blood and bacteria in the urine when the clinical picture is one of septicemia. The cases reported here do not belong to this class. As seen from the short survey of the literature cases have been reported where appendicitis was complicated by pyelitis. It seems most probable that the lymphatics between the appendix and the renal pelvis form the pathway for the infection. If the infection had spread through the blood stream, bacteria would be found in the blood but the blood cultures gave negative results in both cases. There is also a possibility of the infection spreading directly from the appendix to the renal pelvis, facilitated by the topographic proximity of these two organs.

In the available literature no case could be found similar to the second case reported here, where the pyelitis caused a secondary appendicitis. In this case we

must assume that the infection spread by contiguity or through the lymphatics, but if this latter theory is correct, the bacteria must have travelled in a direction opposite to the direction of the lymph flow.

The importance of early recognition of the true nature of such cases does not require any emphasis because it is evident that laboratory findings may lead to the diagnosis of pyelitis and a lifesaving operation may be postponed or not taken into consideration at all. It is not the author's intention to minimize the importance of laboratory findings but a coordination of them with the results of the clinical examination is essential. No appendectomy should be performed without preliminary urine examination but it also should be kept in mind that the presence of pus in the urine does not exclude the possibility of appendicitis.

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# CARCINOMA OF THE APPENDIX

## IN A GIRL OF TWENTY*

WM. EDGAR DARNALL, M.D., F.A.C.S., AND ROBERT A. KILDUFFE, M.D.

ATLANTIC CITY, N. J.

THIS case is reported on account of the extreme rarity of primary carcinoma of the appendix in one so young. It is quite probable that most of the things that are considered rare in medicine would be less rare if all the cases were recorded. No doubt there would be many more cases of carcinoma of the appendix found if every appendix removed were subjected to pathological study. Ewing remarks: "It is interesting to note how the recorded cases of this form of carcinoma have increased in proportion to the attention given to it."

Batzdorf lists 60 cases of primary carcinoma of the appendix out of 13,083, or 0.46 per cent; Batzdorf refers to 186 recorded cases. The age of incidence is from five to eighty years, but most of the cases occur in the third decade.

Extension of the process is relatively uncommon, occurring in about 6 per cent of the cases. The mesenteric and retroperitoneal nodes first become involved.

Miss G. B., aged twenty, from Philadelphia.

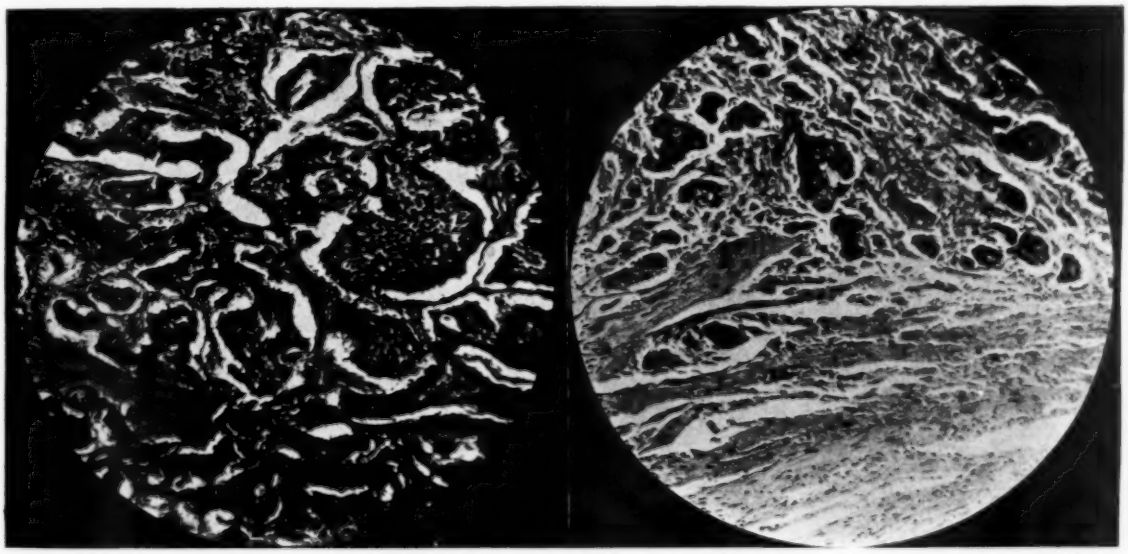

FIG. 1. Low power of central portion of growth. 10 × ocular, 6 mm. objective (Zeiss), Bellows length 20 cm.

FIG. 2. Area showing infiltration of muscularis. 10 × ocular, 6 mm. objective (Zeiss), Bellows length 20 cm.

At the age of two years she had diphtheria. Following that illness she had attacks of pain associated with screaming. According to her mother she described the pain as being in her stomach and buttocks. These attacks would last two or three weeks intermittently. At four years of age she had a prolonged siege of furunculosis. She then had attacks of vomiting which seemed uncontrollable and which would last two or three weeks. When she was seven, she had a copious discharge of pus from the vagina; the discharge lasted about three weeks and there was never any further trouble. This suggests a possible abscess of the vagina or the uterus with spontaneous evacuation. Her menses were established at twelve years of age and were regular and normal. She has been well since that time, but for the past six months she has complained of soreness and pain in her right side. She had what was diagnosed as

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appendicitis about four years ago, but she was not operated upon.

She now weighs 128 lb. and is well developed

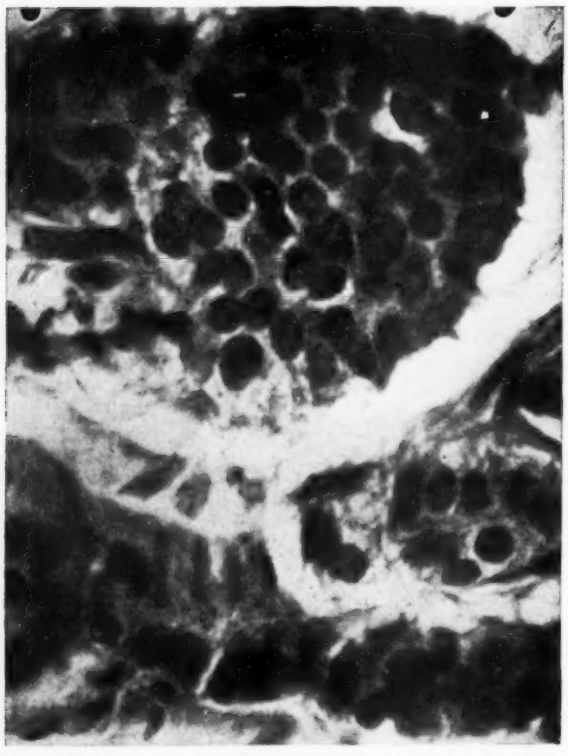

Fig. 3. High power of tumor cells. 20 × ocular, 8.3 mm. objective (Zeiss), Bellows length 20 cm.

and well nourished. On August 16, 1931 she was seized with pain and vomiting. There was no elevation of temperature, pulse 90 and she was menstruating. The next day the pain became localized over the appendix. On account of her previous attack it was thought best to remove her appendix.

On opening the abdomen her appendix was found to be bound down with adhesions. It was not particularly inflamed but was much enlarged and thickened, whitish in color and had a doughy feel on palpation. The cecum was much distended, to the size of a grapefruit. The appendix was removed and the adhesions released. On account of the distention of the cecum and colon it was feared she might have some obstructive condition, which was searched for but not found. The regional glands about the appendix were not enlarged. The uterus, tubes, and ovaries were normal. She made an uninterrupted recovery and did not suffer from postoperative distention or vomiting. Avertin anesthesia was used. Our observations in about a hundred or more abdominal cases has been that patients suffer very little from gas distention and vomiting, postoperatively, after avertin anesthesia, and convalescence is usually smooth.

On opening the appendix the walls were found to be much thickened and of a whitish fibrous consistency with small nodules. There was no pus in the appendix but a small amount of fecal matter was found.

The pathological report is as follows:

*Gross Examination:* The specimen consists of an appendix 6 cm. long which has been sectioned longitudinally in the operating room. It is not particularly congested and presents no striking gross changes, suggesting any marked or acute inflammatory reaction. The distal end, although not showing any very pronounced difference in consistency, being, if anything, somewhat doughy to palpation, is somewhat thickened. Paraffin sections were cut after formalin fixation.

*Microscopic Examination:* The striking feature of the sections is the presence of numerous large masses of epithelial cells which, in general, show a gland-like conformation. These apparently arise primarily in the mucosa where the alveolar arrangement is most marked. They also occur, however, in long fimbriate processes and in smaller groups without any definite arrangement which are found throughout the submucosa and muscularis so that practically the entire thickness of the appendix is involved. Only an occasional mucous gland is found. The epithelial cells of the neoplasm are well differentiated. There are moderately numerous mitotic figures.

*Histological Diagnosis:* Alveolar carcinoma. The immediate histological problem in the study of the sections was the differentiation of the lesion present from the benign embryonal tumors occasionally encountered in the intestinal tract, and still more occasionally in the appendix, and which, because of their histological structure, are commonly spoken of as carcinoid.

Grossly, these occur as single or multiple, firm, opaque nodules. On microscopic examination these are seen to lie in the mucosa or submucosa and, histologically, to be composed of compact, densely stained masses of cells with occasional traces of alveolar conformation, the entire picture strongly resembling a basal celled carcinoma.

While in their simplest form these carcinoid tumors are probably not true tumors and represent either developmental abnormalities or the product of inflammatory heterotopia, the fact remains that, not infrequently, they are precursors of true malignancy with the usual metastatic accompaniment.

For this reason some observers speak of them as pseudocarcinoma and others regard them as true carcinoma although of low grade malignancy.

The distinction, therefore, may be more apparent than real and is the subject of dispute.

In the case at hand, while the growth began in the mucosa, it is found also in the submucosa and infiltrating throughout the muscularis and mitotic figures are relatively numerous.

These findings seem to justify placing it among the true carcinomata although, as suggested by the definite differentiation of the cells, of low grade malignancy.

The general characteristics of the sections are shown in the microphotographs.

Ewing significantly remarks: "The occurrence of a specific type of carcinoma in an atrophying organ, which is often the seat of chronic inflammatory changes is of much theoretical interest. Its peculiar structure and benign course serve to emphasize the principle that each organ probably has its own form of cancer."[1]

[1] Ewing J. Neoplastic Diseases, Ed. 2, Phila., Saunders, 1922.

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*Continued from p. 15.

# ACUTE APPENDICITIS CAUSED BY FOREIGN BODIES

## REPORT OF A CASE OF A TOOTH LODGED IN THE APPENDIX*

KARL A. MEYER, M.D., F.A.C.S., AND PETER A. ROSI, M.D.

CHICAGO, ILL.

FOREIGN bodies in the appendix were first described as incidental observations noted during postmortem examinations. In 1743 Hevin[1] found in the appendices of persons, who during life had eaten a great deal of game, a large quantity of shot which apparently led to no symptoms or lesions. Subsequent reports likewise attached no clinical importance to foreign bodies of the appendix until 1759, when Mestivier[2] reported the case of a man, aged forty-five years, who developed in the right side of his abdomen a large abscess from which foul pus was evacuated. The patient died and at autopsy an eroded pin was found in the lumen of the appendix. This case, the first reported instance of acute appendicitis, aroused the suspicion that foreign bodies and inflammation of the vermiform appendix were etiologically related. As more and more cases were observed the conception became generally accepted that foreign bodies were frequent and constituted a common cause of appendicitis. As a matter of fact, the doctrine became established that true foreign bodies comprised the usual basis for appendicitis. However, what were considered seeds of various kinds proved in the light of subsequent knowledge to be simple coproliths of endogenous origin. Further investigation led to the disclosure that true foreign bodies were only exceptionally responsible for acute appendicitis. That the presence of appendiceal foreign bodies is actually uncommon is exemplified by the reports of a number of observers. Mitchell[3] found two foreign bodies in 250 cases of appendicitis, Kelly[4] four in 1000 cases, and Bell[5] five in an equal number of cases.

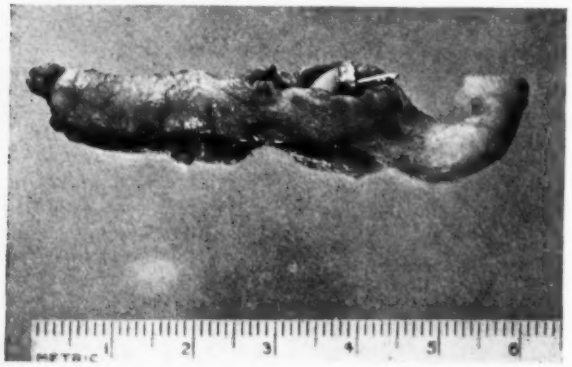

FIG. 1. Partially opened appendix with tooth in situ. Inflammatory swelling and congestion involves that portion of appendix distal to tooth.

The large variety of foreign bodies that have been found in the appendix includes pins, needles, shot, revolver bullets, screws, nails, collar buttons, seeds and bones of various kinds, pieces of wood, worms, pieces of egg shell, barium sulphate, hair, bristles, pebbles, splinters of porcelain, teeth, and metallic mercury. Of the foregoing objects the most frequently found were pins, which comprised 19 of the 110 foreign bodies reported by Berger.[6] Among the least common were teeth, only two instances of which were discovered in the literature.

Upton[7] reports the case of a man, aged seventy-nine years, who swallowed a tooth and about six weeks later developed what appeared to be a strangulated right inguinal hernia. Incision over the hernia led to the evacuation of a large quantity of pus and the tooth. The remains of the "sloughed off appendix" were found at the internal ring. Christeller and Mayer[8] report the case of a man, aged fifty-three years, who was operated upon by Pick for an acute appendicitis. The appendix contained a tooth, the root of which had produced a perforation. In both of these cases the

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presence of the tooth was considered the cause of the acute appendicitis. A third case in which a swallowed tooth led to acute appendiceal inflammation recently came under our observation. The rarity of the affection appears to warrant its publication.

## CASE REPORT

Mrs. M. M., aged fifty-five years, was seen by us thirty-six hours after the onset of a diffuse lower abdominal pain which in the beginning was continuous and dull in character. After approximately twelve hours the pain became more severe and colicky and localized in the right lower quadrant. The patient had noted nausea but did not vomit until twenty-four hours after the appearance of the pain. A cathartic was taken on the day of onset, resulting in a watery bowel movement the following day. The remaining history was essentially negative.

Physical examination revealed a well-developed adult white woman who seemed acutely ill and somewhat listless. The temperature was 100.8°F., the pulse rate 86, and the respiratory rate 22. Abdominal examination disclosed tenderness and rigidity over the entire lower abdomen, most marked, however, on the right side. No masses were palpated. The general physical examination was essentially negative, except for the absence of the right lateral incisor tooth. The white blood count was 18,000. A diagnosis of acute appendicitis was made and immediate operation was advised.

The abdomen was opened through a McBurney incision. The peritoneal cavity contained a thin, gray-white, non-odorous exudate. The appendix, which was easily delivered, was swollen, rigid, and covered with a fibrinous exudate. On its antimesenteric border, at a point between its proximal and middle thirds, there was a pinhead sized perforation. Appendectomy was performed and the abdomen closed without drainage.

Upon opening the excised appendix, an artificial tooth (Richmond crown) was found just beyond the proximal third, distending and occluding the lumen. The post of the tooth had penetrated the wall of the appendix at the point of perforation. The distal portion of the appendix was filled with a mucopurulent exudate.

Following the operation the patient readily acknowledged having swallowed the tooth twenty-four hours prior to the onset of her symptoms but had considered the accident too insignificant to mention at the time she presented herself for diagnosis and treatment.

## COMMENT

Of the factors which determine whether a small foreign body will lodge in or pass beyond the appendix, the specific gravity appears to be important. In the series of 110 foreign bodies reported by Berger,[6] forty-five or 40 per cent were metallic objects of high specific gravity. Heavy particles upon entering the cecum tend to gravitate to its lowermost portion, a point from which the appendix usually arises. In the presence of a patent appendiceal orifice the foreign body can descend further into the lumen of the appendix. Normally the appendix can empty its contents into the cecum by its own peristaltic activity.[9] If, however, the foreign body is heavy, the peristalsis of the appendix will be insufficient to expel it and as a result it will be retained in the appendix indefinitely. The weight of the Richmond crown in our case was an important factor in its becoming lodged in the appendix. The lighter foreign bodies may enter the appendix with the normal fecal content. Their retention, however, occurs in the presence of kinking, angulation, stenosis, or insufficient peristalsis of the appendix.

The change in the appendix that results from a foreign body in its lumen varies with the contour of the object. Sharp and pointed foreign bodies may injure the mucosa as soon as they enter the appendix and give rise to an acute inflammatory process with not infrequent perforation. Many of these foreign bodies, especially pins, may remain latent in the appendix. Pins have been found eroded and incrusted in appendices which were excised long after the ingestion of the foreign objects.

Smooth foreign bodies are less prone to produce primary injury to the mucosa although they may be of sufficient size to

partially or completely obstruct the lumen of the appendix. A complete obstruction may give rise to a mucocele or in the presence of infection to empyema of the appendix. A partial obstruction may produce no immediate change, but the constant irritation of the foreign body may give rise to varying degrees of chronic inflammatory reaction of the appendiceal wall.

The symptoms that are caused by a foreign body in the appendix may be lacking entirely or vary from mild manifestations to those characteristic of acute appendicitis. The absence of clinical symptoms usually occurs as a result of foreign bodies that produce no primary injury to the mucosa and no obstruction. Mild recurrent attacks of pain in the right lower quadrant of the abdomen may result from those foreign bodies that cause partial obstruction or chronic inflammatory changes of the appendix. The symptoms of acute appendicitis occur when there is an injury to the mucosa which acts as a portal of entry for secondary acute infection of the appendix. The symptoms in the case herein reported were due to the injury of the mucosa by the post of the crown together with complete obstruction of the lumen and ulceration of the mucosa of the appendix at the site of the tooth.

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# DIAGNOSTIC SIGN OF CHRONIC APPENDICITIS*

M. W. METTENLEITER, M.D.

NEW YORK CITY

"CHRONIC appendicitis" is quite a common diagnosis nowadays; yet the general opinion about the syndrome is rather vague. The pathological picture is not properly expressed by the clinical name which indicates chronic inflammation. What we find by biopsy are mostly adhesions and residues of more or less acute attacks of inflammation. To be correct we should therefore call the condition recurrent appendicitis.

The symptomatology of the disease is also somewhat obscure. Pain is usually not very marked and roentgen-ray examination alone does not seem to offer definite proof either. A residue of barium in the cecum after seventy-two hours, constant filling of the appendix for many hours or irregularities of filling, etc., are not enough evidence for an absolutely sure diagnosis. We should never forget that the appendix has a peristalsis just like any other part of the intestines; it may happen that we take the roentgen-ray plate at times when the appendix is either just filled or has just emptied itself.

For a number of years I have paid particular attention to the condition of the abdominal wall in all cases where complaints were made about pains in this region. The examination was made by testing the thickness of the skin and the adipose tissue on corresponding spots of the right and left sides between the anterior superior iliac crests, using the thumb and index finger. In doing this one must be sure to grasp the same amount of tissue on both sides; otherwise the comparison will be faulty. There is very often a marked difference in the thickness of the two sides. The right side is decidedly thinner than the left one. Whenever this difference was found, the operation revealed pathological changes of the appendix or of the cecum.

It is understood that these conditions must have existed for some time to have caused the difference in thickness. We are doubtless dealing here with a real atrophy of the subcutaneous tissue and the underlying muscle. Chatzkelson[1] sees the explanation in the permanent contraction of the muscle which diminishes the action of this part of the abdomen and compresses the blood vessels, thus decreasing the circulation of the tissue above. This explanation does not seem correct. Increased contraction means increased activity and always produces hypertrophy. Looking for similar conditions in the body, we find the marked atrophy of the thorax muscle and subcutaneous tissue in chronic tuberculosis, which is well known as "lagging" of the diseased side. It is likely that we are dealing with the same process here, which would mean diminished activity of the right hypochondrium as a protection reflex.

It seems worth while to try for this simple sign in every case where a pathological condition of the appendix or of the cecum is suspected, because its rather uncertain symptomatology needs additional evidence for diagnosis. Whenever we find this difference in the thickness of the skin and the adipose tissue, we can be sure of a pathological condition of this region, usually recurrent appendicitis.

[1] Chatzkelson, B. Zur Symptomatologie der Appendicitis Chronica. *Münch. Med. Wnschr.*, 76: 664, 1929.

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# ACUTE PERITONITIS IN CHILDHOOD*

SYLVAN D. LAZARUS, M.D.

BROOKLYN, N. Y.

ACUTE peritonitis, which occurs most frequently in childhood, still presents many difficulties to the general practitioner, surgeon and pediatrician. Given a case of a child with high temperature and abdominal distention, these signs alone arouse immediate anxiety in all concerned, and it is here that the closest cooperation by those interested in all fields is essential before therapy is instituted. Here also, one encounters a vast diversity of existing opinion regarding the etiology, diagnosis, prognosis and treatment of this entity. In spite of all that has been written on this subject, little help is obtainable because of a similar difference of opinion between the authors found in the literature. For the purpose of clarifying this situation, 42 consecutive cases of acute peritonitis in children occurring over a period of three years (1926–1929) were carefully studied and divided into three classes, namely, (1) pneumococcic peritonitis, (2) non-pneumococcic peritonitis, and these were compared with (3) acute secondary suppurative peritonitis (ruptured viscus). In this group were 9 cases of pneumococcic peritonitis, 13 of non-pneumococcic and 20 cases of acute secondary suppurative peritonitis due to a ruptured viscus. Gonoccocal, tuberculous and other forms of peritonitis were not encountered.

## ETIOLOGY

In all groups studied, age seemed to play no part as an etiological factor and varied from six weeks to thirteen years. The female sex as shown by McCartney,[1] Fraser[2] and others was more frequently affected by pneumococcic peritonitis in sharp contrast to the other groups. Environment, family history and birth were of negative value, and contrary to the findings of Fishbein[3] and Foote,[4] our children were usually well nourished. This entity rarely appeared as a primary disease, but more rightly as a complication of some other infection. It was felt that the classification into primary and secondary peritonitis was misleading. In the pneumococcic group, upper respiratory infections (6 cases), and nephrosis (2 cases) were the primary causes. Peculiarly of the 260 cases of pneumonia occurring in children during this same period of time in the same institution not one was complicated by pneumococcic peritonitis. Rolleston[5] uses this as an argument against its being a blood stream infection. Whether the organism reaches the peritoneum through the blood stream, intestinal tract or other source is still debatable. Yet it would appear as though the source was in the upper respiratory tract and not by extension through the diaphragm, lymphatics, vagina or other suggested sources. This is also true of the non-pneumococcic group, except that the cause of the upper respiratory infection was revealed as a streptococcus in most of the cases (8 cases). Other organisms found in the peritoneum alone or with streptococci were B. coli (2 cases), staphylococcus (1 case) and unidentified organisms (4 cases).

Schwarz and Kohn[6] described cases of nephrosis with peritonitis complicating rhinopharyngitis. Most of their patients showed either a positive pneumococcus or streptococcus blood or peritoneal fluid culture, which fact may possibly point to the relationship between upper respiratory infections, nephrosis and peritonitis. The rôle which the kidney plays in these infections is certainly worthy of further study.

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In acute secondary suppurative peritonitis due to a ruptured abdominal viscus, the staphylococcus, streptococcus and B. coli, were the predominating organisms found, and in only 4 fatal cases in the latter group could the peritonitis possibly be traced to some other primary disease entity, which was in sharp contrast to the other two groups. All these last fatal cases were seen within three days of the onset and were not considered to have been neglected.

## CLINICAL PICTURE

Contrary to general belief, on inquiry our cases in the pneumococcic and non-pneumococcic groups did not show a rapid *onset*. This usually occurred anywhere from ten days to three months after the beginning of the original illness. Clinically, it was found that the *symptomatology* between the first two groups and the severe cases of the acute diffuse secondary suppurative peritonitis could not be differentiated. The cardinal symptoms and signs in the first two groups found in all cases were high temperature, abdominal distention, severe toxemia and abdominal pain and tenderness. Very suggestive symptoms and signs were high pulse and respiration rates, abdominal localization, vomiting and skin manifestations. The *temperature* usually started high at the onset and remained elevated (102–107°F.) during the entire illness with morning remissions of one to two degrees, never reaching normal. Temperatures as high as 109°F. were recorded and when recovery occurred it was usually by lysis, over a period of seven to fourteen days. Except in the terminal premortal stages, the temperature of the acute secondary suppurative group rarely reached above 102°F. The 6 patients in this last group who did record high temperatures died. Four of these incidentally were those complicated by some other disease entity. *Distention*, except in the secondary suppurative appendicitis, was discovered sooner or later. Two-thirds occurred early in the disease. Free fluid was elicited in only 10 per cent, while tympanitis was present in two-thirds of the cases, whereas in the ruptured appendiceal group this sign occurred in only one patient who recovered and in all the 6 patients who died. In the latter group (acute secondary suppurative appendicitis) it usually occurred late in contrast to the other groups. *Abdominal pain and tenderness* were present in all cases studied. The pneumococcic and appendiceal cases showed a tendency to localize early and in the last group, the pain was spasmodic and cramp-like in character in the majority of children. *Toxemia* with marked prostration and stupor occurred in the majority of patients, whereas, this symptom occurred in only 35 per cent of the appendiceal group. *Pulse and respiration rates* were constantly high, the former ranging between 120 and 180, and the latter between 45 and 60, these signs occurring in only 25 per cent of the appendiceal cases. A lowering of the pulse rate in spite of a high temperature was a good prognostic sign. *Abdominal localization* demonstrated itself by the palpation of abdominal masses in three-fourths of the pneumococcic type, the favorite sites being the lower right inguinal, lower left inguinal and umbilical regions. Localization also appeared sooner or later in all the appendiceal cases but in less than one-third of the non-pneumococcic group. *Vomiting* of a non-projectile type occurred early in all the acute suppurative cases, in 85 per cent of the non-pneumococcic group and in 50 per cent of the pneumococcic type. *Skin lesions* such as large blotchy areas of erythema appeared frequently and chiefly on the abdomen, face, nose, extremities and back. Other lesions were circumscribed bluish areas of mottling, bluish-green rings around the umbilicus, prominence of superficial veins, and in one case a large bluish-green ecchymotic lesion on the abdomen. No wheal formations were noted. At first it was felt that these lesions were characteristic of pneumococcic peritonitis, but they were also found with similar frequency in the non-pneumococcic type. None of the

appendiceal cases showed skin manifestations. *Abdominal rigidity* occurred in less than one-third of both the pneumococcic and non-pneumococcic groups, yet 80 per cent of the secondary suppurative appendiceal cases showed definite rigidity of the abdominal muscles. *Diarrhea* was an inconstant symptom in all groups and occurred in only one-third of all the patients studied. *Constipation* was just as infrequent. *Nausea*, except in the appendiceal group (90 per cent) was rarely present. *Chills* occurred in only one case. *Cough* appeared more frequently in the other groups (20 to 30 per cent) rather than in the pneumococcic group and *meningeal signs* were present in only one case.

## LABORATORY PROCEDURE

The blood count is neither diagnostic or prognostic. The average count (18,000) was no higher in the pneumococcic than in the other groups. However, in the pneumococcic and suppurative types, it would appear that a white cell count above this number offered a better prognosis. It would also seem that the urine was of little significance and precipitin tests were of little diagnostic value. Blood cultures, except in the cases of streptococcic peritonitis where 20 per cent showed positive cultures, were of no value. No blood cultures were taken on the appendiceal group.

Contrary to the belief and findings of Fraser,[1] McCartney[2] and others, that the infection reached the peritoneal cavity through the genital tract, smears taken from the vagina were negative for pneumococci in all our females. Peritoneal fluid studies by early peritoneal puncture under proper precautions, or at operation, were alone of value. This procedure usually revealed the causative organism. The physical characteristics of the fluid were likewise of no diagnostic importance. Such procedures as nose and throat cultures, spinal fluid studies, and *x*-rays proved to be of no value.

## DIAGNOSIS

From these studies, one realizes that to obtain a correct differential diagnosis in peritonitis in children the organism must be demonstrated by securing it directly from the peritoneal cavity by abdominal puncture. This procedure when done early offers evidence, assisting not only in diagnosis but also in prognosis. Clinically, it would appear impossible to differentiate between the pneumococcic, non-pneumococcic groups and cases of early severe acute diffuse suppurative secondary peritonitis. However, it was noted that most cases of acute secondary suppurative peritonitis (ruptured appendix) could be differentiated from the other groups by its sudden onset, cramp-like abdominal pains, nausea, muscular rigidity, low pulse and respiration rates (comparatively lower) and the absence of prostration, early toxemia and skin manifestations. Careful histories on children are most essential in that a previous history of staphylococcus (abscess) or streptococcus infection (scarlet fever, streptococcic sorethroat, erysipelas, etc.) is strongly indicative of associated infections by these organisms. Likewise, the history of a recent upper respiratory infection or nephrosis in a female is strongly suggestive of pneumococcic peritonitis.

## PROGNOSIS

In reviewing our mortality chart, one finds that the non-pneumococcic group offers the worst prognosis with only 15 per cent recoveries. The pneumococcic cases give a better prognosis with about one-third recoveries, whereas the acute secondary suppurative group shows a mortality of only 30 per cent. In the appendiceal group where there was evidence of a complicating disease entity, the prognosis was bad. Where laparotomy is performed early or delayed until the appearance of signs of abdominal localization, one finds a better prognosis. It is also noted that the pneumococcic group lived, on an average, twice as long as the non-pneumococcic. A com-

paratively low pulse in spite of a high temperature and respiration rate was also of good omen. In our cases, signs and symptoms such as vomiting, nausea, and localization of abdominal pain and tenderness, in other words those resembling the acute secondary suppurative peritonitis, presented a better prognosis.

### THERAPY

From the histories, it would seem as though those patients who were not treated by drastic cathartics, enemata and other disturbing therapeutic procedures, had a better chance for recovery. This probably prevented distribution of the infectious material and favored early localization. Early laparotomy, with drainage or later when there is definite localization, appeared to offer the best results. Patients upon whom a laparotomy was performed at any time lived on an average of four days longer than the non-operated cases. Complete recovery in all children studied required at least three weeks after laparotomy. Frequent transfusions of whole blood as suggested by some authorities were of no avail. Outside of laparotomy and symptomatic medication for stimulation or comfort, nothing stood out as a therapeutic aid to these patients.

### SUMMARY

It would appear from this review that:

1. Pneumococcic and non-pneumococcic peritonitis in children is rarely primary, but usually complicates infections of the upper respiratory tract, whereas in the acute suppurative peritonitis due to a ruptured viscus (appendicitis) a primary focus of infection is seldom found.

2. The role of the kidney in the extension of the organisms from its source to the peritoneum deserves thorough study as an etiologic factor.

3. Pneumonia in children is rarely complicated by pneumococcic peritonitis.

4. Clinically, cases of pneumococcic, non-pneumococcic and severe cases of acute diffuse secondary suppurative peritonitis cannot be differentiated. However, these entities should be differentiated by symptomatology from acute suppurative secondary peritonitis.

5. Outside of careful early peritoneal puncture for bacteriological study, no laboratory procedure was of diagnostic or prognostic value.

6. Non-pneumococcic peritonitis in childhood offers the worst prognosis (15 per cent recoveries), pneumococcic next (30 per cent) and acute suppurative peritonitis a good prognosis (70 per cent recoveries).

7. Early laparotomy with drainage within three days of the onset or later when there is definite abdominal localization offers the best prognosis.

8. Blood transfusions or other therapeutic procedures were of no avail and the early use of drastic cathartics, enemata or disturbing therapeutic measures are distinctly contraindicated.

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# REFLEX SPASM OF THE STOMACH AND DUODENUM

## CAUSED BY DISEASE OF THE APPENDIX *

J. W. THOMPSON, M.D., F.A.C.S., AND OLIVER ABEL, JR., M.D.

ST. LOUIS, MO.

THE views concerning chronic appendicitis as the cause of gastrointestinal disturbances are varied. Many disturbances in the abdomen have been attributed to the appendix. The diagnosis of chronic appendicitis is by no means easy and no one clinical or laboratory finding is conclusive as Friedenwald and Morrison have recently shown. Rohdenberg[1] in a series of a large number of cases notes a round cell infiltration about the Meissner ganglia which increases until the ganglia have been completely buried. Fibrosis then takes place. From this he concludes that chronic appendicitis is an inflammation resulting from infection and associated with malformation of the sympathetic nervous system. This process is not restricted to the appendix alone but involves organs controlled by the splanchnic sympathetic nervous system in general. According to Rohdenberg the nerve lesions would explain the gastric symptoms, such as attacks of spasm in the gastrointestinal tract and pain.

The cases that we are reporting showed evidences roentgenologically, of filling defects or spastic states in the stomach and duodenum which are consistent with those of ulcer. Some of these cases presented almost typical ulcer symptoms, none responded however to treatment by ulcer regime, and each case showed improvement following removal of the appendix which was pathological in every instance.

Ulcer and cholecystitis are frequently associated with and sequel to chronic disease of the appendix. Solieri[2] believes that the three diseases are connected by a pathogenetic bond.

Larimore[3] states that chronic appendicitis frequently creates a clinical syndrome simulating duodenal ulcer, which can be differentiated only by gastrointestinal *x*-ray. There are relatively few occasions in the field of roentgenology when the roentgenological evidence can alone complete the diagnosis or give indications for treatment. This is demonstrated in the following cases which had clinical chronic appendicitis and also defects in the stomach and duodenum which are roentgenologically suggestive of ulcer but which at operation showed no evidences of ulcer by inspection and palpation of the duodenum and stomach. Of course, the possibility of a mucosal defect cannot be excluded, but with the history extending over a rather long period of time it does not seem probable that one would have many small mucosal defects, rather than a definite ulcer with its secondary scar tissue formation. The improvement in duodenal ulcer following the removal of the diseased gall bladders and appendices is well known. A summary of our cases follows:

CASE I. Miss A. aged thirty-two, troubled for many years with pain in upper abdomen at variable times. No food relief. Nausea, belching, regurgitation and vomiting. Bowels regular. Free HCl 56, total acidity 68. Stool examination negative. No response to ulcer diet.

Gastrointestinal *x*-ray showed a sharp and constant niche deformity in pylorus characteristic of pyloric ulcer. Stomach empty at five and three-fourth hours. Appendix not visualized, slight tenderness. Spastic colon.

*Operation:* Appendix thickened and vessels injected. No evidence of stomach and duodenal lesion.

One year later she has had no return of symptoms and is well.

CASE II. Mrs. L. aged sixty, troubled for fifteen years. Heavy feeling in upper abdomen at night. No food relief. Constipated. Free from

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cathartics. Free HCl 28, total acidity 55. Stool examination negative. No response to ulcer diet.

Fig. 1, Case 1. Arrow indicates marked pylorus spasm. Operation showed pathological appendix, normal stomach, duodenum and gall bladder.

Gastrointestinal *x*-ray showed constant and definite deformity of duodenal cap characteristic of ulcer. Stomach empty at six hours. Gall bladder visualized, with stones. Appendix not visualized, tenderness at base.

*Operation:* Chronic thickened gall bladder, dilated common duct, containing sand stones in the gall bladder. Gall bladder and appendix removed. Stomach and duodenum appeared normal.

Ten months following she has had no gastric symptoms.

Case III. Mr. F. aged thirty-eight, troubled for one and one-half years with pain in upper abdomen two or three hours after eating. Food and soda relieves. Considerable belching. Bowels constipated. Frequent cathartics. Free HCl 44, total acidity 62. Stool examination negative. No *x*-ray. No response to ulcer diet.

Operation showed chronic appendicitis. Appendix removed. Stomach and duodenum normal. One and one-half years later he has had no return of gastric disturbances.

Case IV. Mr. D., aged forty-two, troubled

Fig. 2, Case 1. After operation, indicating smooth contour of pylorus. Patient's symptoms relieved.

from fifteen to twenty years with pain in midepigastric region two to three hours after eating. Bicarbonate of soda gave slight relief. Considerable gas and bloating. Constipated. Frequent cathartics. Free HCl 64, total acidity 88. Stool negative. No response to ulcer diet.

*X*-ray showed constant and definite deformity of duodenal cap, characteristic of ulcer. Stomach empty at five and one-half hours. Appendix not visualized, tenderness.

*Operation:* Appendix found thickened and injected. Retrocecal. Removed. Stomach and duodenum normal.

Case V. Mr. B., aged thirty-two, trouble for nine or ten years. Pain in region of umbilicus; also right lower quadrant one to three hours after eating. No food relief. Belching and gas. Waterbrash. Constipated. Free HCl 30, total acidity 46. Stool examination showed four plus guaiac. No response to ulcer diet.

*X*-ray showed evidence of adhesions in pylorus and duodenum. Niche deformity

of the lesser curvature. Appendix narrow and constricted at the base. Proximal portion dilated. Tenderness over appendix. Stomach empty at six hours.

*Operation:* Stomach and duodenum negative. Gall bladder negative. Appendix long, dilated at the tip. There was a Jackson's veil. Appendix removed.

One and one-half years later has had no return of gastric symptoms.

Case vi. Mr. V., aged thirty-five, troubled for one and one-half years with pain in pit of stomach two and one-half hours after eating; also at night. Food relieves. Belches. Waterbrash. Constant frequent cathartics. Free HCl 62, total acidity 76. Stool examination negative. No response to ulcer diet.

*X*-ray showed pylorus and cap spastic. Previous *x*-ray showed evidence of duodenal ulcer. Appendix was visualized, dilated and tender. Stomach empty at five hours.

*Operation:* Stomach and duodenum normal. Appendix thickened, injected and beaded. Appendix removed.

Two and one-half years later good result. No abdominal discomfort.

Case vii. Mr. B., aged thirty-four, troubled for seven years with more or less constant discomfort in epigastrium. Some food relief. No response to ulcer diet. Belching. Bowels regular. Free HCl 62, total acidity 70. Stool examination negative.

*X*-ray of gastrointestinal tract showed a definite deformity of the duodenal cap. Appendix barely visualized, slight tenderness, Stomach, duodenum, and gall bladder normal. Appendix thickened, congested, and there was concretion in the appendix. Appendix removed.

One and one-half years later has had no return of symptoms.

Case viii. Mr. R., aged thirty-one, troubled for six or eight years with bloating, belching, vomiting, and waterbrash. Bowels constipated. Free HCl 92, total acidity 109. Stool examination negative. No response to ulcer diet.

Gastrointestinal *x*-ray showed constant deformity of duodenal cap, characteristic of ulcer. Appendix visualized, narrow, constricted, beaded, and tender.

*Operation:* Appendix adherent and thickened. Appendix removed. Stomach and duodenum negative. Two years later has had no return of gastric disturbances.

Case ix. Mr. K., aged twenty-eight, troubled for six months. Pain in region of umbilicus immediately after meals. Soda relieved some. Some belching. Bowels constipated. Free HCl 62, total acidity 86. Stool examination negative.

Gastrointestinal *x*-ray showed constant pyloric defect. Trace of barium in stomach at six hours. Appendix visualized, constricted and beaded. Tender.

*Operation:* Stomach and duodenum normal. Adhesions about the gall bladder and duodenum. Appendix constricted, injected and thickened. Appendix removed.

Two and one-half years later had no return of gastric disturbances.

Case x. Mr. L., aged twenty-five, troubled for three years with pain in epigastrium. No food relief. Nausea, belching, and waterbrash. Bowels regular. Free HCl 20, total acidity 36. Four plus guaiac in stool. No response to ulcer diet.

Gastrointestinal *x*-ray showed constant cap deformity. Stomach empty at five hours. Appendix not visualized. Tenderness at base.

*Operation:* Stomach and duodenum normal. Gall bladder normal. Appendix adherent, retrocecal, and retroperitoneal. Definite angulation. Appendectomy.

Two and one-half years later improved with no gastric symptoms.

Case xi. Mr. T., aged forty-eight, troubled for one month with generalized pains, nausea, and waterbrash. Constipated. Free HCl 35, total acidity 50. Stool examination negative.

Gastrointestinal *x*-ray showed constant deformity of duodenal cap. Appendix not visualized. Stomach empty at five and one-half hours. Gallstones and a partial cystic duct occlusion following cholecystography.

*Operation:* Stomach and duodenum negative. Appendix adherent, thickened and congested. Gall bladder was thickened and filled with stones. Cholecystectomy and appendectomy.

Has had no disturbance of two years.

Case xii. Mr. J., aged thirty-one, troubled for six years with belching and vague abdominal pains. Free HCl 33, total acidity 57. Stool examination negative. Previously treated for duodenal ulcer without results. This patient while under observation developed an acute appendix which was removed. At that time exploration of stomach and duodenum showed them to be normal.

Has remained well one year following operation.

Case XIII. Mrs. K., aged forty-seven, troubled for many years with pain in upper abdomen. Free HCl 23, total acidity 40. Stool examination negative.

Gastrointestinal *x*-ray showed definite deformity of cap. Irritable appendix. Stomach empty at five and three-fourth hours. Stomach and duodenum negative. Gall bladder adherent to first part of duodenum and there were stones. Appendix elongated and thickened.

*Operation:* Cholecystectomy and appendectomy done.

Remained well for two and one-half years following operation.

Case XIV. Mr. A., aged forty, troubled for six months. Heaviness in upper abdomen after meals, belching, and constipation. Free HCl 30, total acidity 50. Stool examination negative. Put on ulcer diet without relief.

Gastrointestinal *x*-ray showed a constant and definite deformity of duodenal cap. Stomach empty at five and one-fourth hours. Appendix visualized. Retrocecal, narrow, constricted at the base, dilated at the tip and tender.

*Operation:* Stomach, duodenum, and gall bladder normal. Thickened appendix which had shown evidence of an old perforation. Appendectomy done.

Improved after nine months and no return of gastric symptoms.

Case XV. Mr. H., aged thirty-four, troubled for two years with gnawing in epigastrium, chiefly at night. Food relief. Considerable belching and gas. Constipated.

Gastrointestinal *x*-ray showed constant and definite deformity of cap characteristic of ulcer. Stomach empty at five and one-half hours. Appendix faintly visualized, beaded, constricted at base, and tender. No improvement while on ulcer diet.

*Operation:* Stomach and duodenum normal. Appendix thickened and injected. Removed.

Improved after one year.

Case XVI. Mr. R., aged twenty-two, troubled for eleven years. Pain in abdomen and distress after meals. No food relief. Belching.

Gastrointestinal *x*-ray showed definite deformity of duodenal cap. Appendix visualized. Retrocecal and tender. Congenital fixation of the cecum. High Jackson's veil. Appendix chronically inflamed.

*Operation:* Appendix chronically inflamed. Appendectomy.

Has remained well for six months.

Fig. 3, Case XV. Arrows indicate deformity of duodenal cap due to supposed ulcer. Operation disclosed normal duodenum. Pathological appendix removed.

In summarizing these cases it is noted that the ages vary between twenty-two and sixty years, 11 however, being between the ages of twenty and forty. There were twice as many males as females. Three of the cases had definitely pathological gall bladders as well as chronic appendicitis associated with the spasms of the stomach. Diseased gall bladders may also cause spasms in the gastrointestinal tract. Fourteen of the 16 patients were constipated. Eight of the 16 gave a typical history of pain one to three hours after meals, but did not respond to ulcer diet. The stomach was empty in all cases between five and six hours. There was a definite hyperacidity; the average acidity of the 16 cases following Ewald-Boas test meal was free HCl 50, total acidity 67. It is quite possible that this might be a factor in the causation of ulcer, namely: chronic appendicitis, causing definite spasm in the region of the

pylorus and the duodenum with associated hyperacidity over a period of time may lead to the formation of ulcer. The *x*-ray

Fig. 4, Case xv. After operation, demonstrating normal contour of duodenal cap. Dietetic regime, postoperative, identical to that before operation.

in all cases showed definite evidences of what we term chronic or pathological appendicitis. In 5 of the cases the appendix was not visualized. Larimore states that the normal appendix is visualized only by the opportune coincidence of its filled condition to the roentgenographic or fluoroscopic observation. Non-visualization never necessarily means an occluded or non-fillable appendix. The normal appendix can and does empty itself very shortly after the cecum has emptied. By observing the appendix, both fluoroscopically and roentgenographically, at frequent intervals and especially when the cecum is filled, we have come to the conclusion that non-visualization of the appendix, especially when there is tenderness in the region of the appendix and with secondary small intestinal patterns of the irritative form, means a diseased organ.

In all cases a right rectus incision was made, large enough to afford adequate exposure of the stomach, duodenum, and gall bladder. It is not justifiable to remove a supposedly chronically inflamed appendix with a McBurney's type of incision. The patient should receive the benefit of a careful examination of other organs which might be contributing to his symptoms because of unsuspected pathologic changes.

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# SPINAL ANESTHESIA*

LEON M. BOGART, M.D.

FLINT, MICH.

ONE hundred fifty-two patients have been operated upon by the writer under spinal anesthesia, comprising a variety usual to any one doing general surgery. In using spinal anesthesia we must achieve, from the patient's standpoint, a painless and insensitive field. From the surgeon's standpoint to the foregoing must be added accessibility to the pathological process. Thirdly and most important of all, the objects both from the patient's and the surgeon's viewpoint must be accomplished with at least as much safety as with the inhalation anesthesias.

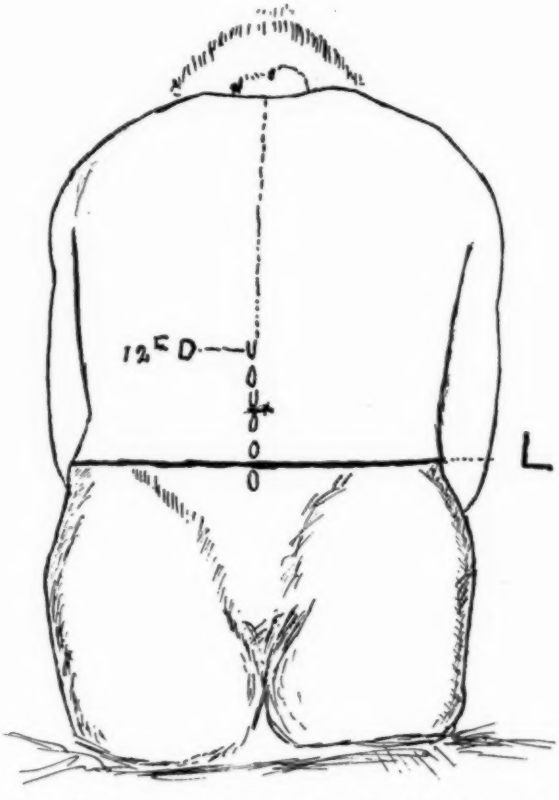


FIG. 1. Sitting posture, patient bowed and head brought down on thorax. Arms brought over sides of abdomen and pressing in. Feet should rest comfortably upon stool. X, Most useful place to introduce needle. L, Imaginary line drawn across crest of ilia, being fourth interspace. Note that needle is introduced second interspace above by feeling spines of vertebrae. (After Labat.)

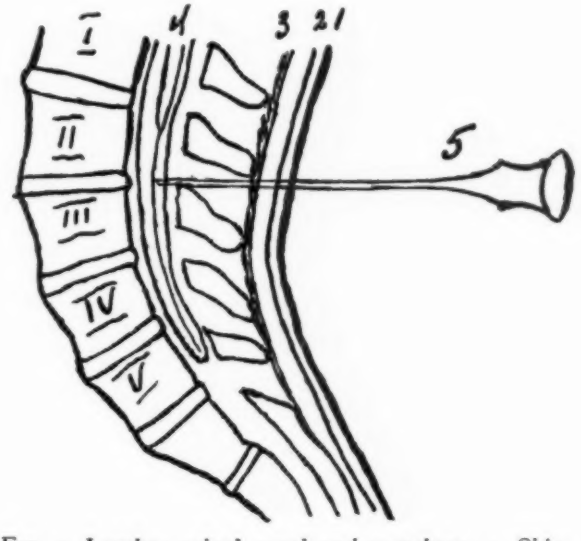


FIG. 2. Lumbar spinal canal and vertebrae. 1, Skin. 2, Lumbosacral fascia. 3, Supraspinous ligament. 4, Cauda equina beginning at upper end of second lumbar vertebra. 5, Needle in position at second lumbar interspace. Note position of needle at posterior compartment of spinal canal.

There will probably never be a foolproof anesthetic, but with due carefulness and foresight spinal anesthesia is as safe as any evolved, causing less morbidity. Susceptibility to any medicament, anesthetic or otherwise, is varied, being different even in a given individual at different periods. In the early days of spinal anesthesia many outward results were due partly to crude drugs and partly to faulty technique. Jonesco, Babcock, Labat and many others have used spinal anesthesia with unvarying success. Koster recently reported 6000 cases in which one fatality could be ascribed to the anesthetic. Many surgeons advocate spinal anesthesia for cases of extreme risk. An anesthetic used and

* Read before the Hurley Hospital Staff Clinical Conference, Nov. 15, 1931.

preferred in extreme cases surely ought to be recommended in the ordinary case.

The laity as well as many of the profession should be educated to the benefits of spinal anesthesia. A good many millions of spinal anesthesias have been given of late and the popularity of this form is increasing, due no doubt to the approximate absence of after-effects on the patient. The relaxation induced by spinal anesthesia is almost complete; it allows the surgeon greater accessibility to the pathological process with smaller incisions and the necessity of huge retractors is lessened. The surgeon must not regard the soft tissues lying between the pathological process and the outside as of no consequence. Skin, fascia, muscle tissue and peritoneum have definite functions and layers; scars should be as small and as neat as possible. Metal retractors, especially self-retaining retractors, should be avoided whenever possible. Their restricted use will give the patient more postoperative comfort and the surgeon less anxiety. Postoperative vomiting and ileus no doubt owe a great deal to rough usage of the tissues by retractors.

Spinal anesthesia is induced by some form of novocaine introduced into the spinal canal, where it is carried by the spinal fluid to the sensory and motor roots. The sensory roots have a greater attraction for the drug than the motor roots. Personally I feel that there are no contraindications to spinal anesthesia. Some surgeons warn against the use of spinal anesthesia in patients with extremely high or low blood pressure, basing their contention on the sudden drop of pressure sometimes occurring in the course of anesthesia, which alarms one who has not given many spinal anesthesias. Many of my patients did not experience a great drop in blood pressure; some had only from 20 to 40 points' drop and a few, in whom the drop appeared alarming, came through just as well. Not a few fell asleep during the operation. The only contraindication I observe is extreme neurosis. Obesity and cardiac enlargement are not to be regarded as contraindications if proper precautions in technique, discussed later, are followed.

The oldest patient operated on by me under spinal anesthesia was sixty-eight years of age, the youngest eleven years. There were 22 patients weighing over 180 lbs. and 3 of the patients weighed over 250 lbs. There were 6 patients with a blood pressure of 190/110 and over. There were 4 cases of ruptured ectopic pregnancy in which the blood pressure was less than 100/40. There were many patients operated on, who were poor risks, and the three deaths in this series could not be ascribed to the anesthetic. One death was due to a ruptured duodenal ulcer which developed two weeks subsequent to a subphrenic abscess. One death from cancer of the rectum occurred on the third day following a perineal resection of the rectum, and one death on the seventh day postoperative followed an extensive gastric resection.

## TECHNIQUE

One and one-half hours before operation we administer morphine gr. ¼ and morphine gr. ¼ ten minutes before operation. This dosage is to be decreased or increased as indicated by the weight and temperament of the patient. The spinal region should be shaved as required. On the operating table the patient is painted with an antiseptic solution and washed off with alcohol. I prefer the sitting posture, with the spinal column bowed, not bent, though I do not see any particular objection to the recumbent posture. The main object is bowing of the spinal column.

A sterile towel is drawn across the crests of the ilia. The fourth lumbar interspace is on a line with the iliac crests. I usually use the second lumbar interspace, the second above the interspace in line with the iliac crests. The gloved thumb finds the third lumbar spine and with the thumb in position over the third lumbar spine the nail of the thumb is dipped into the space above and indented. Thus by experience will be found the right place to introduce the

needle. I use an ordinary Bier needle, 3 or 3½ inches and 18 gauge with a firm stilette in it. Into the marked second interspace the contents of a 1 c.c. ampoule of 1 per cent novocaine containing ephedrine is introduced, infiltrating the skin and deeper tissues. The needle is then introduced by steadily thrusting it through, being held firmly and guided into the midline. The passing of the needle into the spinal canal is felt as a sudden gentle release of pressure against the needle. The stilette is then withdrawn and from 4–8 c.c. of the spinal fluid are allowed to accumulate into an ampoule or medicine glass containing neocaine crystals.

Neocaine was used throughout in the 152 cases reported herein. The stilette is then reintroduced into the needle so that no spinal fluid is unnecessarily lost, while the crystals of neocaine are thoroughly dissolved in the withdrawn fluid by drawing in and expelling the contents with an ordinary Luer type glass syringe. When fully dissolved, which takes a few seconds, the fluid is drawn into the syringe, the air is expelled, the stilette is withdrawn from the needle and the syringe is attached to the needle. Draw a little of the spinal fluid into the syringe once or twice, to make sure that the needle has not changed position, and inject the fluid, withdrawing some spinal fluid into the syringe once or twice. The greater force used in injecting the fluid and the greater amount of the fluid used as a solvent will determine the height of the anesthesia. When injection is completed, withdraw the needle quickly and put the patient in 10 degree Trendelenburg position.

### DOSAGE

I found it expedient to compute 0.001 gm. for each pound of body weight and to add to the computed amount from 0.03 gm.–0.05 gm., a larger dose being used for work on the gall bladder or gastric region. Given a patient weighing 150 lbs. in whom gall bladder or gastric surgery is indicated, I would use one ampoule of 0.15 gm. and one ampoule of 0.05 gm. Given an individual weighing 150 lbs. for a lower abdominal or perineal procedure, I would use one ampoule of 0.12 gm. plus one ampoule of 0.05 gm. of neocaine. The highest dosage I have used (0.3 gm.) was in a woman weighing 268 lbs., without any outward results.

### COMPLICATIONS DURING ANESTHESIA

Respiratory embarrassment, cyanosis, extreme drop of blood pressure, retching, vomiting are all best combatted by putting the patient in the extreme Trendelenburg position and instructing him to pant. Administration of $CO_2$ through a catheter is also instituted. Ephedrine, adrenalin or other stimulants are not necessary. In obese patients with cardiac enlargement the extreme Trendelenburg position should not be prolonged any more than necessary. The length of the anesthesia may vary from one to two hours and I often supplement the anesthesia by injecting under the lateral side of the rectus abdominis, outwardly, ½ per cent novocaine, to infiltrate the area of the lower intercostals. Likewise the peritoneum around the proposed incision is injected with ½ per cent novocaine. The local supplement is only resorted to where a prolonged procedure is necessary as in pyloroplasties, exploration of the biliary ducts, etc. When the peritoneum has been closed, $CO_2$ is given during closure of the fascia and skin. Deep respiration is thus induced. The patient is returned to bed on a stretcher in moderate Trendelenburg position and is left in bed in the same position for six hours. The patient is instructed to breathe deeply. Normal salt solution, 1000–2000 c.c., is given under the breasts or inside the thighs slowly: the solution must be warm. The patient is otherwise treated as any other surgical patient.

Extreme care must be exercised so that the hot water bottles do not come in direct contact with the skin of the lower extremities, for sensation may be slow in returning. The nursing care of these patients is less arduous as gas pains and ileus are rare,

some patients being alarmed at the absence of the traditional postoperative pains.

Catheterize as you would any other patient, as indicated. Narcotics are rarely needed after the first postoperative day.

Complications following spinal anesthesia have been very minor. Occasionally a patient complains of a headache, which can usually be controlled by an ice bag. There have been no other complications in this series. There was a marked absence of postoperative vomiting. Many patients received liquids per mouth the first few hours postoperative.

## SUMMARY AND CONCLUSION

One hundred fifty-two major surgical cases were operated upon under spinal anesthesia, neocaine being used, with the simple technique described. Many cases were in the extreme stage. No fatality attributable to the anesthesia occurred.

Spinal anesthesia is a safe procedure, allowing the surgeon greater freedom of manipulation and conducive to less trauma, resulting in greater comfort to the patient and a smoother convalescence.

TABLE I

LIST OF OPERATIONS

| | |
|---|---|
| Hysterectomy | 15 |
| Pelvic and abdominal | 33 |
| Gastric | 8 |
| Gall bladder | 17 |
| Appendectomies | 31 |
| Hernia: femoral, inguinal and postoperative | 23 |
| Intestinal, including resections of cecum | 6 |
| Ruptured extra-uterine pregnancy | 4 |
| Compound fractures, tibia and fibula | 2 |
| Prostatectomy | 1 |
| Resection of coccyx | 1 |
| Rectal, including perineal resection | 11 |

# OBSERVATIONS ON 100 OBSTETRICAL CASES WITH AVERTIN ANESTHESIA*

WILBER S. NEWELL, M.D.

SYRACUSE, N. Y.

FOR the past five years the attention of the obstetrical world has been directed more and more towards devising means of relieving the pain and suffering accompanying childbirth. For years there were no satisfactory means of relief from this nightmare except hypodermic morphine and a few whiffs of chloroform. The old twilight sleep was an attempt in that direction but was soon discarded. The use of etheroil as an analgesic became quite popular a few years ago, and with its advent many other drugs have been used with more or less satisfaction and certainly with definite improvement over the old methods.

In the summer of 1926 Willstaedter and Duisberg of Germany introduced avertin, to be used alone for rectal anesthesia or to be supplemented by other narcotics including morphine and ether. There has been much discussion as to its advantages and disadvantages, and there has been a preliminary report of the Council of the American Medical Association upon avertin.[1] They conclude their report with the decision not to admit the drug to new and non-official remedies until further studies have been made, until the contraindications have been satisfactorily established, until the technique has become more satisfactory and until the advertising had been revised to omit misleading statements. It is not the purpose of this paper to argue the advantages of avertin with either the Council or with any of the clinics where it has been used experimentally and reports either favorable or non-favorable made upon the subject. But in the short space allotted to me I wish to relate briefly my personal experience with the drug as used in a series of 100 cases and compare its advantages with the other means of obstetrical anesthesias.

With the exception of two classes of patients, the cases in which I used avertin were taken in succession and not selected. These two exceptions were, first, those patients admitted to the ward who were already well advanced in labor and who did not know their pregnant weight, and were in such condition that we were unable to get them out of bed and weigh them, and therefore unable to determine the dosage; second, those cases who were ready for immediate delivery upon their admittance to the hospital.

Avertin is tribromethanol, a white crystalline substance, soluble in 30 parts of water at 40°c. The manufacturers are marketing avertin in the form of avertin fluid of which 1 c.c. contains 1 gm. of avertin dissolved in tertiary amyl alcohol. For basal anesthesia the average dose of avertin fluid, that is the 1 gm. of the drug in the tertiary amyl alcohol, is 0.10 c.c. for every kilogram of body weight and the manufacturers suggest that for obstetrical anesthesia an average dose of 0.06 c.c. for every kilogram of body weight be given. It has been my experience that this dosage produced no amnesia, and only a slight analgesia, and its effect lasted only about one-half hour; as a result of this observation I have gradually adjusted my dosage so that I give a basal anesthesia dose for 20 lbs. less than the pregnant weight.

When the dose is determined, distilled water sufficient to make a 2.5 per cent solution is heated to 40°c., a glass receptacle that can be tightly closed, with a

[1] *J.A.M.A.*, 95: No. 19.

* Read before the Syracuse Academy of Medicine October 20, 1931.

capacity of 500 to 1000 c.c. being used. The dose of avertin fluid is then measured with a graduated cylinder or pipette and added to the water; the flask is then stoppered, inverted and shaken vigorously until all globules of avertin fluid have disappeared. The solution must not be allowed to cool, as cooling causes the precipitation of avertin in crystalline form and when this occurs the solution must be discarded. Just before injection we place 2 to 5 c.c. of the prepared avertin solution in a test tube and add 1 or 2 drops of a 1 to 1/1000 aqueous congo red solution. A pure orange red color should develop; if a blue or violet color develops the solution must be discarded as it has become decomposed and hence is dangerous. This test is a reliable safeguard only if the solution has been prepared with distilled water, therefore ordinary tap water should never be employed. This solution of avertin, at body temperature, is injected into the rectum, usually with a bulb syringe attached to a male catheter. By this means if the patient has a contraction during the installation of the fluid, the fluid is forced back into the syringe, and when the contraction is passed can be reinjected into the rectum, thus avoiding loss of fluid.

It is my routine to administer avertin as soon as pains become at all annoying, regardless of the amount of dilatation. Within ten minutes after the administration of the solution, the patient is sound asleep. In at least 50 per cent of the cases uterine contractions continue unabated, they increase in force and frequency and become of a longer duration just as normally as in those cases where no anesthetic is administered. In the remaining 50 per cent there is a decrease in the frequency of the contractions but apparently no change in the force or duration, this decrease occurring more frequently when dilatation is less than three fingers at the time of the avertin injection. In these cases I then administer hypodermatically a small dose of thymophysin in accordance with the amount of decrease noted in the frequency of contractions, and repeat this dose of thymophysin in ten minutes if necessary. This procedure has never failed to bring back the uterine contractions to the point where they were before avertin was administered.

The effects of avertin usually last from one to three hours, which is as a rule of sufficient length for the usual multipara to deliver herself. In primiparas where labors are long drawn out, it is often necessary to repeat the avertin injection. This I do without hesitancy, but not until the patient is definitely out from under the influence of the first dose. In very few instances we find that after the administration of the drug, although the patients are unconscious, they are exceedingly restless, tossing themselves from one side of the bed to the other, and must be constantly watched to keep them from falling to the floor. This condition has been controlled in every instance by the administration of 1/6 grain of morphine hypodermically. When the patient is completely under the anesthetic there is a relaxation of the cervix and vaginal walls which permits labor to progress rapidly, and in my opinion decreases the duration of labor by at least 25 per cent; one multipara going from one finger's dilatation to delivery in twenty minutes after administration of avertin. I find in the majority of cases there is no need for an auxiliary anesthetic at the end of the second stage, except in those instances where the delivery of the child and the termination of the effect of the drug coincide; in such cases I use nitrous oxide and oxygen inhalations.

Regarding the baby; there has been no necessity in any one of the 100 cases to use any means whatsoever to start respiration, it has always been of good color, cried immediately and never caused anxiety on the part of the obstetrician. Lacerations and episiotomies have been markedly less, due, I think, to the complete relaxation obtained by this anesthesia. After delivery blood chemistry and urine examinations were done on 60 per cent of this series and

in no instance was an abnormal report received. The only annoying after-effect which seems to follow the administration of this anesthetic is intestinal gas, usually appearing about twelve hours after delivery, but which is easily controlled by a soda enema.

I think there are distinct advantages of this form of anesthesia over the others now in use, and these advantages are not only of my own observation but are also the observations of multiparas who have previously been delivered under etheroil and gas oxygen, and later delivered under avertin. There is an absence of nausea and fogged mentality following the use of the drug, there is a more complete analgesia and just as much amnesia. The amount instilled into the rectum is much less than in etheroil and therefore easier to retain, and neither does it give the burning sensation complained of so frequently when the etheroil is used. There is greater feeling of relaxation and well being when the patient awakens, and much less shock after obstetrical operations.

The contraindications for the use of avertin as given by the manufacturers are: advanced pulmonary tuberculosis, severe organic disease of the liver and lesions of the rectum. Other less definite contraindications are serious diseases of the kidney, blood acidosis and grave cachexia.

ELECTRICITY IN MEDICINE

# ELECTROSURGERY*

GRANT E. WARD, M.D.

BALTIMORE, MD.

ELECTROSURGERY is the application of high frequency electric currents for the destruction and removal of diseased tissue or for cutting through normal tissue with diminished bleeding. Its development has been due to the gratuitous cooperative labors of a group of physicists and medical and surgical investigators, to all of whom acknowledgment is due. As one reviews the history of this technique, it becomes evident that advances were often simultaneous and quite independent in widely separated areas, making it difficult at times to assign priority in the construction of apparatuses and improvement in technique. I shall give briefly, therefore, a resumé of the outstanding steps in the rise of this new surgical modality.

Fundamentally, electrosurgery owes its inception to the construction of the Leyden jar by Musschenbrock of Leyden in 1746 and to the discovery of electromagnetic induction by Oersted in 1821. Henry in 1842 showed that Leyden jars discharged with oscillatory vibrations. Hertz demonstrated in 1884 that vibratory waves pass from a generator to a distant receiver without tangible electrical connections.

William J. Morton adapted the principles of these discoveries to medicine and reported his static induced current before the New York Academy of Medicine on March 3, 1881, published in the *Medical Record* of April 2 and 9, of that year. He used an oscillation frequency in the neighborhood of 100,000,000 per second and a low tension current with a soft agreeable effect and no shock and with or without muscular contractions as desired. Sir Oliver Lodge's investigations in 1888 confirmed Morton's work.

Biological effects of these electrical phenomena were further studied and reported by d'Arsonval of Paris[1] who found that high frequency currents of high tension could be passed through living tissue without pain or muscular contraction if the alternations exceeded 10,000 per second, the only physiological effects being an elevation in temperature associated with marked respiratory changes and an increased absorption of oxygen and elimination of carbon dioxide. The generator used consisted of two Leyden jars as condensers with a spark gap between them connected to a coil without an iron core, an autotransformer. Two years later, he introduced the Rhumkoff coil (induction coil)[2] as a source of power and passed the current through a helix of large wire with but few turns far apart, deriving a powerful current with a spark from 5 to 15 mm. long in air. Upon placing animals in the circuit between the electrodes, without any direct connection with them, he observed that they were subjected to an extremely strong induction that gave rise to great modification in the excitability of isolated nerves and muscles and no less interesting changes in vital functions.

Tesla, in December, 1891, published his additional arrangement enclosing d'Arsonval's course spiral in a fine wire coil of many turns which further stepped up the current.

P. Oudin working along similar lines in 1893 devised a resonator, or solenoid, of a capacity and self-induction determined

[1] Action physiologique des courants alternatifs. *Compt. rend. Soc. de biol.*, Paris, vol. 43, May, 1891.

[2] Production des courants de haute frequence et de grande intensité; leurs effets physiologiques. *Compt. rend. Soc. de biol.*, Paris, vol. 45, Feb., 1893.

* Read before the New York Electrical Society, Dec. 16, 1931.

according to the capacity of the condensers, the external plates of which are connected, the one to one extremity of this solenoid, the other to a point of its elevation, variable according to the intensity of the effects to be obtained. To the free end of the solenoid is fixed the electrode with which the patient is acted upon.[3]

These currents were used for so-called medical diathermy; that is, temperature elevation of a part of the body within physiological limits. It remained for Joseph Riviere to demonstrate that by increasing the density of the current with a small electrode, destructive effects are obtained. He, following an accidental discovery, treated an indolent ulcer on the back of the hand of a musician by spraying it with a spark from d'Arsonval's apparatus. Under repeated treatments, the ulcer healed. Riviere then enlarged the field of usefulness and attracted the attention of the medical profession. Pozzi called his modification of the method "fulguration" and for many years this modality was employed in the treatment of accessible tumors. Beer of New York in 1908 first adapted fulguration to the destruction of bladder tumors through a cystoscope, thus opening new vistas.

Independent of these discoveries, Finley R. Cook, also of New York, while working with a static machine received a superficial burn from a spark which gave him the idea of destroying tumors. Consequently, he used it for the eradication of small skin tumors, such as warts and moles and acne pustules, infected tonsils and hemorrhoids. Not aware of the European advances, he reported his results in 1906 and 1907.[4]

All of this work was with a uniterminal application through a single electrode. E. Doyen, however, ventured further, making use of a biterminal connection of the d'Arsonval coil, one, the inactive electrode a large metal plate beneath the patient, the other active and much smaller, concentrating the current and producing much higher temperatures, 500° to 600° C., with more powerful effects. With this current, Doyen was able to destroy cancerous tissue to a depth of 1 or 2 cm., using a flat disc electrode of 1 to 2 cm. in diameter, applied to the surface for several seconds or minutes as the case demanded.

It is to William L. Clark of Philadelphia that electrosurgery owes its progress in America. He took the then somewhat crude apparatuses and cumbersome technique employed to a limited extent in the treatment of small, superficial tumors and developed both the uniterminal and biterminal currents by increasing the amperage and therefore heat production for the destruction of large, deep-seated malignant disease. His currents were much smoother and of higher frequency, having been split up by the introduction of a multiple spark gap. Clark and his co-workers were also the first to study the biological effects under the microscope.[5]

During the past few years, a third form of electrosurgical current has become available and popularized by the high-sounding title "radio knife." De Forrest in 1908 first obtained a cutting current from the vacuum tube apparatus. He, Neill and Sternberg experimented on dogs, making fine, clean incisions with little bleeding. Eager to construct an instrument for wider therapeutic uses, de Forrest failed to attain his ambition because of lack of medical cooperation. Attempts were subsequently made in Germany by Cohen and Stoye, an apparatus consisting of transformer, spark gap, and d'Arsonval coil being used. Later, Clark experimented with a similar type of instrument and discarded it. George A. Wyeth, working in the Loomis Laboratory in New York, in the summer of 1923, constructed an apparatus producing a cutting current and then made practical

[3] Report of the Special Committee on the Static Induced Current, American Electro-Therapeutic Association, September 27, 1900.

[4] *New York Med. J. & Rec.*

[5] Clark, W. L., Asnis, E. J., and Morgan, J. D. *Atlantic M. J.*, vol. 27, 1923.

use of his discovery. Wyeth soon published startling results, which, together with the extensive work of Clark, suddenly attracted the attention of the medical profession and stimulated the application of high frequency surgical currents in practically all fields of surgery. Manufacturers have been of the greatest importance in the development of efficient machines, low in price, and operating with comparative ease. To them we owe no little debt of gratitude for the elaborate research, both expensive and time-consuming.

The cutting current of Wyeth was easily controlled and very fine, allowing primary healing when desired, the thin layer of dehydrated tissue on either side of the incision being absorbed as the wound united. With these three available currents, tumors are destroyed in situ, either by desiccation or coagulation and removed with the cutting current. Wyeth's machine, combining all three currents in one cabinet, was expensive, and in an effort to economize the manufacturers produced apparatuses wherein the radio tubes were replaced by spark gap oscillating circuits modelled after those mentioned above. Unwittingly, a great advance was made, for with the spark gap instrument a tremendous amount of heat is generated simultaneously while cutting, the lethal temperature penetrating to a depth of 1 or 2 mm. on each side, reducing the two-step operation of first destruction and then excision to a single one of destruction during excision as pointed out by Groff.[6] This is the most valuable current for the treatment of large, ulcerated tumors, or, by applying the current through a loop, otherwise inaccessible tumors are removed piecemeal with safety. By varying the size and shape of electrodes and by electrifying certain surgical instruments, a great range of adaptability is attained.

To recapitulate then: our present-day apparatuses are of two main types referred to as the spark gap generator or the radio tube generator.

The first requirement in a spark gap generator is an efficient step up transformer, usually having the primary and secondary coils wound on opposite legs of a laminated sheet iron core in the form of a hollow square. Sometimes these transformers are immersed in oil for cooling purposes. A choke coil control, between the primary of the transformer and the line current, regulates the amount of current flowing into the transformer. From the secondary of the transformer, the current passes through the oscillating circuit, consisting of Leyden jars or plate condensers, according to the design of the apparatus, a multiple spark gap, and an inductance coil. In medical literature the inductance coil having a biterminal connection with the patient is named after its designer d'Arsonval and that coil having a uniterminal connection, called Oudin, after its inventor. From such an apparatus, damped high-frequency currents are obtained, the oscillations, spark frequency, voltage, and amperage being under accurate control.

Current variations are obtainable from the tiniest, almost invisible spark for the dehydration of minute tumors about the eye to flashing sparks for blasting out large, deep-seated growths. By approximating the spark gap and keeping down the voltage, tissue is severed as readily as with the sharpest scalpel, with the tremendous advantage of sealing capillary blood vessels and lymphatic channels, limiting dissemination of the disease. Strengthening the current drives the heat deeper with destruction of 1 or 2 mm. of tissue on each side of the incision. For coagulation destruction only, without the cutting property, still stronger currents are obtained, literally cooking to a depth of 8 to 10 mm. Larger blood vessels are sealed with such currents, the thick coagulum preventing primary union, which is not essential and often impossible with large tumor masses that leave disfiguring

[6] Sutten, H. *Med. Herald and Physictherapist*, Aug., 1929.

defects. The chief aim is to eradicate all malignant cells and cover the wound with a sterile coagulum preventing implantation or dissemination. At best, in such instances, healing is by granulation and subsequent scarring, plastic operations later repairing the deformity.

The radio tube generator is useful and important by reason of its compactness and ease of operation; for an equal amount of power, it being about one-third the weight of the spark gap apparatus. Many of the functions of the spark gap instrument are reproducible by the tube generator, especially cutting, with the added advantage of a greater constancy in the primary union, when desired in clean cases, as the operating frequency is always definite and the heat penetration of the undamped current more easily controlled.

Heavy coagulation currents are, however, not usually so readily and satisfactorily produced with tube generators as at present constructed: the smooth deep-heating properties of the well-balanced spark gap being replaced by a flame-like long spark obscuring vision, charring tissues quickly and preventing deep coagulation. Particularly is this true when the effort is made to combine coagulating with cutting properties called for in removing large ulcerative growths about the face and oral cavity. Recent advances, however, indicate that these difficulties are being overcome.

The construction of the usual form of vacuum electrosurgical generator is similar to that of a radio transmitter, the tubes being connected in full wave rectification, the second tube working during the idle half-cycle of the first.

The passage of concentrated high frequency currents through living or dead tissues develops an intense heat within them, causing well-defined gross and microscopic changes enhanced perhaps by a yet unknown electrical or magnetic biochemical phenomenon. In contradistinction to all previously used forms of heat therapy, the destructive effects are generated within the tissues themselves, which form a part of the circuit traversed by the current. It is, therefore, evident that the fundamental principles of our electrosurgical procedures are utterly diverse and never-to-be-confused with the various electric cauteries.

The biophysical reactions of the passage of an electric current through tissue are in general like the physical changes when the current passes through solutions, being electrolytic rather than metallic: that is, the transfer of electricity is accompanied by the transfer of charged matter. This is a complicated process in tissues as compared with solutions, for protoplasm is not a molecular chaos, as in simple solutions, but the molecules are held more or less fixed in the heterogeneous polyphase colloid; its ions not being free to migrate in every potential gradient. Migration is hampered at the colloidal interphases, especially at such bounding interphases as separate the nucleus from the cytoplasm and those which form the cell walls. Under the influence of a potential gradient, these semipermeable membranes become polarized and the ions of adjacent phases become concentrated at these membranes, the molecules taking on new orientations in the electrical field with consequent disturbance of the protoplasmic pattern. Because the accompanying electrification does not support the continued existence of the protoplasm, the electric current is lethal. This lethal effect, due to polarization, may be avoided, if we do not permit the current to flow long enough to bring about the molecular disarrangement with the accompanying electrification. Death of the tissue is prevented if, instead of interrupting the current after it has been flowing a short period of time, its direction is changed, thus reversing the potential gradient in the protoplasm and, correspondingly, the migrations and orientations. If this frequency of alternation is high enough, sufficient current may be passed through the tissues, so that no effect other than heating will appear. The

rise in temperature depends entirely upon the density of the current, the current-strength, and the time of application. When large pad electrodes are used, the current is disseminated throughout part of the body, for instance an extremity or joint or even the entire body, raising the temperature within physiological limits and with therapeutic effect. If one of the electrodes is made small enough to concentrate the current sufficiently, temperatures are reached far above that tolerated by living tissue. It is this destructive characteristic which is utilized in electrosurgery. Under the action of such high frequency currents as described, tissues are dehydrated to a white powder, easily brushed away, or coagulated in their own boiling juices to a white clot, and they are further heated, if desired, until converted into a dense, dry, contracted homogeneous mass, which is removed with no fear of dissemination of disease. Too prolonged application of the current beyond the dried out coagulum will cause oxidation and carbonization, the carbon then becoming an insulator against further penetration of the current and therefore heat, a condition not comparable with good electrosurgical technique.

Time will not permit a complete discussion of the complex biophysical and electrical phenomena of electrosurgery. A few words, however, are timely to describe cutting effects.

With the usual amount of current impressed upon the operating electrode, arcing and sparking occur between it and the tissues, the depth of destruction depending upon the amount of current employed. The electrode and the tissues act as plates of a condenser and the tissue changes produced are profoundly influenced by the characteristics of the wave train. If the wave trains are markedly damped, dehydration and coagulation result, but undamped wave trains of sufficiently high density sever tissue as cleanly as a sharp scalpel; rapid movement of the electrode keeps the destruction at a minimum along the cut surfaces. Increasing the amount of damping together with the current strength adds to the coagulation and dehydration of the cut surfaces. This is the real value of the spark gap generators for vascular tissues are severed without loss of blood except from large arteries. These are quickly caught with a hemostatic clamp through which the current is then passed, sealing the vessel within its grasp.

In our surgical terminology three names are used to designate three separate currents and their respective tissue alterations. The uniterminal application of a spark gap damped current from Oudin's resonator is called "electrodesiccation," first described by Clark, Asnis, and Morgan.[7] The biterminal connection of the patient and d'Arsonval coil with its heavier effects was termed electrocoagulation by Doyen.[8] Electro-cutting is performed chiefly with a biterminal connection from properly balanced spark gap or radio tube apparatuses, although it is possible to sever tissue with a uniterminal current when intense enough.

Electrodesiccation, as the name implies, is the dehydration of living tissues by a moderate heat usually induced by the passage of a uniterminal high frequency current. As the water evaporates from the cells, the tissues assume a blanched, arid appearance, and small moles, warts, corns and other skin blemishes are brushed off in a white dry flake or powder, leaving a considerably toughened, dry, white surface. Under the microscope, the tumor cells are seen drawn out and shrunken with elongate nuclei, uniformly taking a heavy blue hematoxylin stain; they are spindle-shaped and preserve their cellular characteristics with walls and nuclei easily discernible. The stroma cells are likewise elongated and shriveled with nuclei more compact.

Electrocoagulation is a more advanced destruction, usually accomplished by a

[7] *Idem; Radiology*, 11: 4, 1924.

[8] Surgical Therapeutics and Operative Technique. 1917, Vol. 1.

strong biterminal current generating higher degrees of heat and coagulating tissue proteins into a homogeneous material which grossly assumes a white parboiled appearance in contradistinction to the carbonization of the hot cautery instruments. Owing to the intense heat, a truly dry stage is not seen until the treatment is prolonged. The tissues first boil in their own fluids and surrounding lymph, quickly forming a white coagulum. When much connective tissue is present, the coagulum is tough and removable only with the cutting current or instrument; if epithelial cells predominate, the coagulum is granular and friable and yields readily to the abrasion of a curet.

Microscopically the changes are progressively more marked than after desiccation, varying from dried shriveled cells all the way to a uniformly granular debris of stroma and tumor cells. With the usual application, the structure of the stroma cells tends to remain faintly outlined, with scattered nuclei, appearing shrunken and elongated, in the hyalinized mass. Other cells suffer more complete destruction and are partially exploded by the steam formed within them, obliterating their identity. Those receiving most heat are completely coagulated in a uniformly staining residuum.

A microscopic examination of the cut edge reveals two distinct layers: the first is a thin line of finely divided particles of carbon formed by the breaking down of the large protein molecule; back of this lies the second broader desiccated or coagulated layer, with sealed lymphatics and capillaries. When primary union is desired in clean cases lighter currents are employed, and electrodesiccation is more in evidence; but when excising massive growths, with heavier currents, coagulation occurs along the edge of the incision for considerable depth.

The healing of electrosurgical wounds depends entirely upon the type and strength of current and the use to which it is put. In ordinary surgical procedures, such as gall-bladder operations, breast amputations, appendectomies, etc., the cutting current has been given a trial substitution for the scalpel in an effort to determine any real value over the sharp knife. With carefully chosen currents, excellent primary union is obtained and the operation is rendered much less bloodless. It is claimed by many that the heat sterilizes the skin edges, preventing wound infections, hastening healing. However, with the difficulties attendant in securing the proper current and the added complexity of technique, it seems likely that electrosurgery will never replace the scalpel in such operations except perhaps in breast amputations. Some observers have had great difficulty with wound healing, probably due to the use of unnecessarily heavy currents.

Small skin blemishes dried up by the current are left as a protecting sterile coagulum to separate in from one to three weeks, depending upon the size, when usually epithelialization has taken place beneath the smaller one; with larger involvements, the wounds heal by granulation after separation of the scab. With massive malignant tumors it goes without saying that a long period is necessary for healing. At operation the wounds are left covered with a sterile coagulum 1 or 2 mm. in thickness. Under proper aseptic and antiseptic treatments, this coagulum gradually sloughs away, leaving a healthy, vascular, granulating surface, upon which, if occasion demands, many small skin grafts can be planted. In other instances, healing is by scarring and epithelialization under careful surgical dressings, and at a suitable time repair operations are performed.

A characteristic of electrosurgical wounds is the soft pliable cicatrix, lessening disfigurement and making plastic operations easier. This is of special value about the eye where dense contractures, from other forms of therapy, distort the lid, likewise in the mouth flexibility of the tongue and cheek is necessary.

The field of electrosurgery is enlarging by leaps and bounds. From its meager beginning in the destruction of small, superficial skin diseases, it has reached out into practically all surgical specialities.

In selected cases where surgical operations are contraindicated, tonsils are destroyed in one or several sittings, as necessary in the given case, with no bleeding and very little discomfort. Hemorrhoids are also treated with similarly good results.

Following Clark's lead, we are now able to remove massive malignant disease, involving the eye and orbit, the nose, tongue, floor and roof of the mouth, even when there is extension to the jaw bones. Cancer is no respecter of tissue and invades bone, requiring special technique for its resection. With electrosurgery, all organic matter in bone is destroyed, the dead bone then being removed with impunity. Recently I devised an electrosurgical rongeur, which cooks and sterilizes the bone as it is bitten off. During the course of the electrosurgical operations, large vessels are encountered. These require special attention, either by the direct application of a blunt electrode, simultaneously collapsing the vessel and sealing the walls together, or by a hemostatic clamp applied and the current passed down this clamp to seal the vessel within its grasp, as suggested by the author several years ago.

Cancer of the nasal sinuses, formerly treated by mutilating operations with poor results, can now be cleaned out with electrosurgery, making way for the application of radium to destroy any lingering disease, which might lurk in these inaccessible places. Usually the antrum is approached by reflecting a flap of skin from the face and the massive tumor taken out with an electrified wire loop or curet. Approaching it in this fashion, all ramifications are outlined and sterilized with this remarkable current.

Large tumor masses in the neck, formerly inoperable, are now removed by wide dissection, using a heavy cutting current. In these operations large tributary vessels should be previously ligated to guard against hemorrhage.

Cancer of the bladder and prostate gland, always serious problems, are much more rationally treated by electrosurgery alone or in combination with other forms of treatment. In small bladder tumors, the method first described by Edwin Beer in 1908 is still, with some modification, employed. Through an operating cystoscope he treated and eradicated papillary growths, applying the current on a long, insulated instrument. More extensive involvements require opening of the bladder and destruction and removal with the current applied on suitable forms of electrodes, particularly a wire loop with which the growth can be scooped out without bleeding. The base is then thoroughly treated by the application of radium directly through the open wound. Obstruction at the neck of the bladder is now relieved by specially devised instruments for resection with electrosurgery. This can be done under local or spinal anesthesia with a minimum of incapacitation.

Certain vascular organs, as the liver, spleen and kidneys, are now approachable with this blood-controlling surgical adjuvant. The author, associated with Pierce and Scott, has experimented on animals, discovering the proper type of current for incisions in these organs. Practical application is now being made in the resection of diseased portions of the kidney or opening it for the removal of stones and tumors. I recently operated on a human liver with marked diminution in the amount of blood lost.

Tumors in the abdomen not infrequently attach themselves so densely to the intestines that resection endangers the intestinal wall, risking the life of the patient. We can now dissect these from the loops of bowel with a limited amount of bleeding and great benefit to the patient. Investigative work is continuing to make electrosurgical currents more adaptable to gastrointestinal surgery.

Chest surgeons following Jacobus and others working through a telescopic instrument, release dense adhesions, attaching the lung to the chest wall, collapsing tuberculous lungs for rest and healing.

Under the advancing leadership of Harvey Cushing brain tumors are now removed with increased facility. This method brought such startling results that Cushing recalled patients, whom he had formerly given up as hopeless, shrank the tumor with the coagulating current, and removed it; others were scalloped out with an electrosurgical loop, collapsing the walls, reducing its size, and permitting withdrawal through the small exposures of skull and brain operations. I have had similar experiences operating with Charles Bagley of Baltimore. We were able to reduce the size of several of these distessingly difficult tumors and remove them, a feat which would have been absolutely impossible in former years.

Time does not permit elucidation of the difficulties and refinements of the technique of electrosurgery, all of which are acquired by diligence and experience. An adequate surgical training is a prerequisite to the adoption of electrosurgery. It little behooves the novice to take up such a powerful weapon, dangerous in the hands of the unskilled.

# RESULTS OF A NEW METHOD FOR THE REPAIR OF INGUINAL HERNIA*

H. NIESSEN, M.D., AND W. J. POTTS, M.D., F.A.C.S.

FRANKFORT ON THE MAIN, GERMANY OAK PARK, ILL.

IN 1929 Schmieden[1] described a new method for the repair of inguinal hernia, not as a substitute for the Bassini

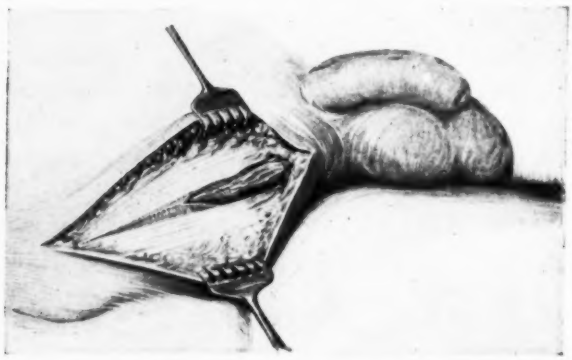

FIG. 1. Incision and exposure of cord. (From Schmieden).

method, but rather as an aid in selected cases. The principle of Schmieden's method is embodied in a scheme of transplanting the cord to a newly made internal inguinal ring in the oblique and transversalis muscles at the outer edge of the rectus. This transplantation, made possible only by raising the testicle out of the scrotum, allows a complete and solid closure of the entire inguinal floor. Many recurrences appear at the site of the internal ring, and to eliminate these this new operation was devised. This report is concerned with a follow-up study of 102 cases operated upon by this technique between January, 1929 and December, 1930 in the Frankfort Clinic.

The technique of the operation briefly is as follows:

The usual skin incision for inguinal hernia is made, and the external aponeurosis exposed. It is cut parallel with its fibers over the cord (Fig. 1), the incision being extended well above the internal ring. The medial leaf is caught with two forceps and retracted upward to expose the underlying muscles. The cord is then freed from its bed and the testicle slowly drawn from the scrotum. All bleeders, even the tiniest, are carefully tied off as they are exposed. The gubernaculum of Hunter, usually present as a well-defined fibrous strand at the inferior pole of the testicle, is doubly tied and cut, the ligatures being left long to permit repair at the close of the operation. A wet compress is placed in the scrotum. Raising the testicle out of the scrotum is an essential step in the operation, and, although a somewhat radical procedure, permits more careful and complete separation of the sac and its ligation high in the inguinal canal. Furthermore, it makes possible a more thorough inspection of the inguinal triangle for direct hernia, and an unobstructed view while making the repair.

The sac is dealt with in the usual manner.

A 2 to 3 cm. strip in the internal oblique and transversalis muscles is next separated from the external surface of the peritoneum by dull dissection. This muscle strip is raised with a dull retractor, and about 2 cm. above its lower border and at the edge of the rectus sheath an opening large enough to allow the testicle to pass through is made in the muscle by separating the fibers bluntly (Fig. 2). The opening is maintained with two single blade retractors, and the testicle drawn through from below upward by grasping the gubernaculum with an artery forceps. The testicle is then wrapped in compresses wet with salt solution, and laid out of the operating field while the repair is effected.

[1] Schmieden. *Arch. f. klin. Chir.*, 157: 617, 1929.

* From the Surgical Clinic of the University of Frankfort-on-the-Main, Germany, Prof. V. Schmieden, Dir.
Submitted for publication July 10, 1931.

The first suture is put in the upper angle of the wound, and closes snugly the former region of the internal ring. The second suture is placed in the lower angle of the wound, and anchors firmly the edge of the rectus sheath to the periosteum of the pecten pubis. One or two stitches in this area are very important to remove all tension from the sutures of the transversalis and internal oblique muscles to Poupart's ligament (Fig. 3). The entire floor of the inguinal triangle is now completely closed. A stitch or two closes the muscle slit snugly but not tightly about the cord. The severed ends of the gubernaculum are brought together, and the testicle replaced in the scrotum, care being exercised not to twist the cord. Figure 2 illustrates how the newly formed internal ring lies beneath the upper leaf of the external oblique aponeurosis. The external ring is formed in the lower angle of the wound; the aponeurosis of the external oblique muscle being simply sewed edge to edge or overlapped according to the method of Girard. The loose fatty and connective tissue at the base of the scrotum and the subcutaneous tissue are closed with fine catgut sutures; the skin with silk.

The wound is dressed and sufficient padding placed over it to maintain pressure. The scrotum is well supported by a cotton pad bandaged firmly into position. The routine postoperative care is exercised.

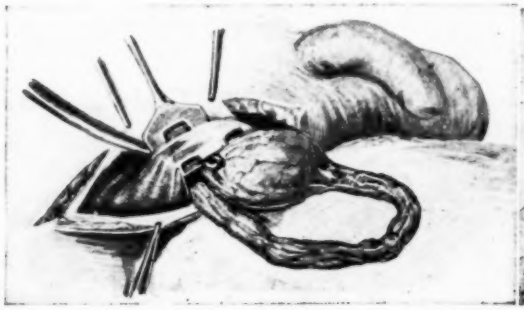

Fig. 2. A 2 cm. strip of transversalis and internus muscles has been raised. Testicle is being drawn through newly formed internal ring. (From Schmieden.)

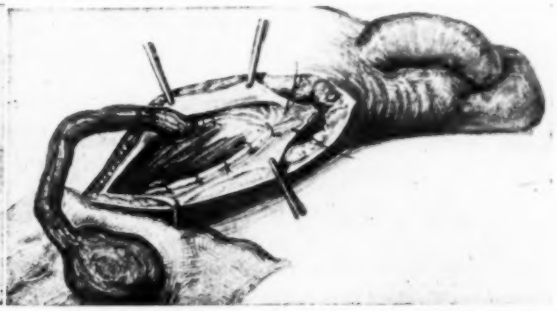

Fig. 3. Inguinal floor has been repaired throughout its entire length. Sheath of rectus has been sutured to periosteum of pecten pubis. (From Schmieden.)

## RESULTS

During the years 1929 and 1930, 102 patients were operated upon by the foregoing technique, including 6 cases with bilateral herniae, making a total of 108 operations. Of these 2 were sliding, 3 incarcerated, and 5 recurrent. In 16 patients with bilateral herniae the smaller was repaired according to the Bassini method.

In Table I a résumé of the cases and the important facts concerning operation and immediate postoperative findings are given.

Table II shows graphically the results of our follow-up examinations in 66 cases and replies to questionnaires in 22 cases.

There was no mortality. Three cases developed postoperative bronchitis, one pneumonia, one pleuritis, and 3 thrombosis in the femoral veins, 2 of which had subsequent inconsequential pulmonary emboli.

Ether anesthesia was used for 50 cases, usually with avertin as a base. Spinal anesthesia was given in 31 cases without any untoward results. Local anesthesia was used for the early cases, 27 in all, but was later practically abandoned when it was observed that hematoma developed frequently following its use; due most likely to the constricting action of adrenalin on small vessels which later dilated and bled.

Six wound infections occurred, 4 of which were stitch abscesses. One patient put a piece of wire into the wound and produced

a fistula which healed promptly when the wire was discovered and removed. The sixth case of infection associated with a hematoma formed an abscess beneath the skin and required incision. None of the cases with infection developed recurrences.

The position and condition of the testicle on the operated side were very carefully observed. In 8 instances it lay from 1 to 2 cm. higher than the opposite one, but this had not been detected by the patient. The testicle lay high at the base of the scrotum

Table 1

| Age in Years | Number of Operations | Normal Healing | Hematoma | Infection | Anesthesia | | | Days in Hospital | Weeks off Duty |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ether | Spinal | Local | | |
| 20 | 6 | 6 | | | 3 | | 3 | 15 | 5.8 |
| 20–30 | 30 | 22 | 8 | | 18 | 2 | 10 | 16.3 | 6.4 |
| 30–40 | 20 | 15 | 2 | 2 | 12 | 3 | 5 | 17 | 6.0 |
| 40–50 | 17 | 14 | 2 | 1 | 6 | 7 | 4 | 20.6 | 7.0 |
| 50–60 | 22 | 19 | 3 | 2 | 8 | 12 | 2 | 17 | 6.1 |
| Over 60 | 13 | 9 | 2 | 1 | 3 | 7 | 3 | 19.4 | 7.0 |
| Totals | 108 | 85 | 17 | 6 | 50 | 31 | 27 | 17.5 | 6.3 |

Table 11

| Age in Years | Examined | Reported by Letter | Total | Atrophy of Testicle | Testicle High in Scrotum | Pain in Scar | Recurrences | Observation Time | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 3–12 Mos. | 12–27 Mos. |
| –20 | 6 | | 6 | | | 1 | | 2 | 4 |
| 20–30 | 17 | 8 | 25 | 1 | 6 | 6 | | 6 | 19 |
| 30–40 | 5 | 6 | 11 | | | | | 2 | 9 |
| 40–50 | 15 | 2 | 17 | 3 | 5 | 1 | 3 | 6 | 11 |
| 50–60 | 16 | 3 | 19 | | | 3 | 3 | 8 | 11 |
| Over 60 | 7 | 3 | 10 | | 1 | 1 | | 4 | 6 |
| Totals | 66 | 22 | 88 | 4 | 12 | 12 | 6(6.8%) | 28 | 60 |

Hematoma developed in 17 cases, varying in degree from discoloration and slight swelling to distention of the scrotum. A number of times puncture was made without obtaining blood. The hematomata were not caused by frank hemorrhage but by oozing of blood into the easily distended tissues. They were treated by support and dry heat, and had in most cases absorbed by the time of discharge from the hospital.

in 4 patients and was associated with moderate atrophy, the testicle being approximately one-half the size of the opposite one.

Pain in the scar was complained of by 12 patients, and described as a twinge in the inguinal region following violent exercise, and in two instances associated with sexual intercourse.

Disturbances of sensation associated with a weakness of the abdominal wall

(pseudoherniae) in the region immediately above the former internal ring were found in 3 patients and ascribed to errors in the technique of dealing with the nerves.

Recurrences were found in 6 of 88 cases, 66 examined personally and 22 reached by letter, or 6.8 per cent. The observation time of the majority of patients was between one and two years. All of the recurrences were in patients between forty and sixty years of age, and developed within the first postoperative year. This fact of early recurrence agrees with the observations of others. Although there is no guarantee that other recurrences will not appear we believe that a reasonably fair picture is presented. A short review of the important facts in the histories of the recurrent cases follows.

## REPORT OF CASES

Case I. Engineer, aged forty-two, with a right-sided inguinal hernia for two years supported by a truss. Irreducible at time of admission. Operation under local anesthesia. Normal postoperative course. At follow-up examination a hernial opening 1 cm. in diameter was found in the middle of the scar; a small direct hernia most likely due to a cutting through of one of the muscle to ligament sutures.

Case II. Cafe proprietor, aged fifty-one, much overweight, with right-sided direct hernia for two years. Operation: Avertin ether anesthesia. Fat-streaked musculature, weak fascia. Primary wound healing, slight scrotal hematoma, light attack of bronchopneumonia. Re-examination: In lower angle of the scar a large recurrence which developed almost immediately after discharge from the hospital. Direct hernia.

Case III. Workman, aged forty-three, with large right-sided inguinal hernia for thirty years, umbilical hernia and varicocele. Operation: Avertin ether anesthesia. Both direct and indirect herniae were found. Usual technique employed. Normal healing. Patient returned to work four weeks after discharge from hospital. Follow-up examination: Recurrence of direct hernia in lower angle of scar. It appeared almost immediately after returning to work.

Case IV. Turner, aged fifty-two, with large right-sided irreducible hernia, chronic bronchitis, emphysema and dyspnea. Immediate operation under local anesthesia. Normal healing except for small hematoma. Follow-up examination ten months after operation: Small hernia in lower angle of scar which will admit only the tip of the finger. No bulge. There was considerable question whether this was not a small hernia. It is listed as one of our recurrences.

Case V. Laborer, aged forty-six, with recurrent hernia operated upon six weeks previously elsewhere with recurrence after four weeks. Examination revealed two bulges, one apparently below the inguinal ligament. Diagnosis: inguinal and femoral herniae. Operation under spinal anesthesia was difficult because of disturbed anatomical relations and scar tissue. No femoral hernia found. Follow-up examination six months postoperative: Complaint of pain in lower angle of scar. No visible hernia. After jumping, straining and coughing a slight protrusion could be felt which upon pressure disappeared with a gurgling sensation to the palpating finger. No hernial opening was demonstrable. It is likely that this was a femoral hernia missed at operation. It is included as one of our recurrences.

Case VI. Plumber, aged fifty-two, with scrotal hernia for two years, incarcerated a few hours. Operation: Viable bowel replaced, cord edematous and thick. Follow-up examination: Patient had returned to work fourteen days after discharge. Recurrence in upper angle of scar. Re-operation: Hernia through newly made internal ring in the conjoined muscles. The swollen testicle necessitating a large slit in the muscles may have been a factor in this case. The muscle fibers below the cord were unchanged. The sac was removed and the muscle slit closed. No further trouble to date, two months after second operation.

## DISCUSSION

In a consideration of our percentage of recurrence, 6.8, it is essential to bear in mind that this technique has been used only in adult males with a large, a recurrent, or a sliding hernia. During this same period of time many children as well as

adults were operated upon by the standard Bassini technique.

Statistical reports of recurrences are fewer than descriptions of new operations and modifications of technique. The percentage of recurrent herniae reported depends more upon the investigator, the age of the patient, and the type of hernia dealt with than upon the operator. B. L. Coley[1] reports 8.7 per cent recurrence of indirect inguinal hernia in adult males operated upon at the Hospital for Ruptured and Crippled in New York. Coley and Hoguet[2] report 0.57 per cent recurrence or less than 1 per cent from the same hospital. The difference lies in the simple fact that the latter statistics include many male children in whom recurrence is practically unknown. Both reports are based on careful follow-up work. If 8.7 per cent of indirect inguinal hernia recur in a hospital where thousands of cases are operated upon by a few skilled surgeons the average percentage is undoubtedly higher.

The method here described is recommended for the adult male with an indirect inguinal hernia with a large internal ring, and for sliding hernia. Its advantage in the latter is apparent. After replacing the bowel and dealing with the partial sac, the internal ring can be closed solidly and reenforced with fascia lata if desired.

In this series there has been no recurrence at the site of the former ring. The use of living fascia from the rectus or thigh to support the region medial to the deep epigastric artery will be tried in an effort to lessen the incidence of subsequent direct herniae.

[1] Coley, B. L. *Ann. Surg.*, 80: 242, 1924.

[2] Coley, W. B., and Hoguet. *Ann. Surg.*, 68: 255, 1918.

# ARTERIOVENOUS ANEURYSM OF THYROID VESSELS*

JULIUS J. SELMAN, M.D., AND SAMUEL O. FREEDLANDER, M.D.

CLEVELAND, OHIO

IN spite of the frequency of operations upon the thyroid gland situated in a region where so many large vessels are in juxtaposition, to our knowledge only one case of arteriovenous aneurysm has been reported.[1] We have had another such case:

A white female, aged twenty-nine, was admitted to the Cleveland City Hospital February 2, 1931 with a complaint of edema of the legs, shortness of breath, palpitation, cough, and nervousness. She stated that she had had "heart trouble" for ten years. At the age of thirteen she had a goiter but it was not until some years later that the symptoms of palpitation, nervousness, and loss of weight became pronounced. In 1927 a thyroidectomy was done with an improvement in her general health and nervousness. One year ago she began to have a severe cough. In spite of negative *x*-rays and sputum, she was sent to a tuberculosis sanitarium where she remained nine months. During this time her chief complaints were nervousness, palpitation, and unproductive cough.

Physical examination showed a poorly nourished and developed woman, not acutely ill. She was very apprehensive. On the left side of the neck in the region of the upper border of the thyroid cartilage there was a marked pulsation. Over this pulsating area there was a palpable thrill which persisted during the whole cardiac cycle with systolic accentuation. A loud continuous bruit was heard over this area.

The rest of the physical examination was negative. Electrocardiogram showed a normal mechanism. Fluoroscopic examination of the heart showed the left ventricle slightly globular. Pulse varied from 80 to 90. Blood pressure 114/80. After compression of the pulsating area, it rose to 130/95.

*Operation* March 14, 1931. Local anesthesia. A transverse incision was made on the left side of the neck at the level of the upper border of the thyroid cartilage.

There was a pulsating mass in the upper angle of the wound which proved to be an elongated, dilated, tortuous superior thyroid artery. The artery, becoming larger in size, continued into an irregular sac over the upper part of which there was a pulsation and a thrill. The pulsation was lost at the lower part of the sac but the thrill persisted. At the lower end the sac divided into several large tributaries which seemed to empty into the internal jugular vein. From the medial side smaller vessels emptied into the sac.

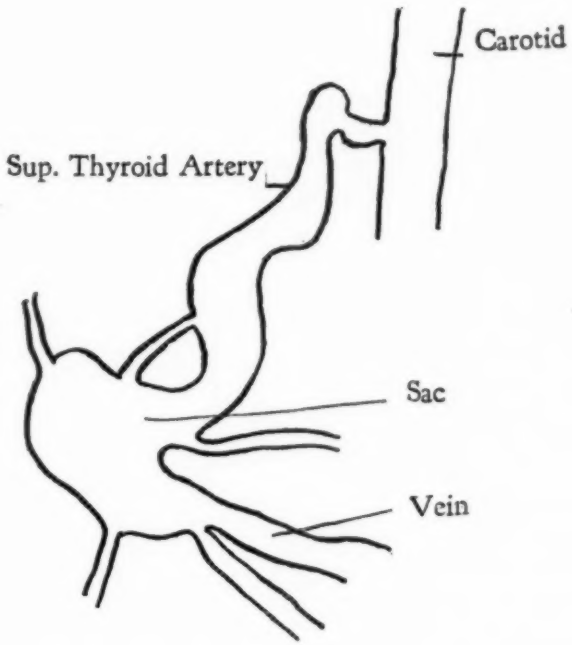


FIG. 1.

The superior thyroid artery was ligated close to the carotid. All collateral vessels were ligated, and the entire mass excised.

Following the operation, the cough and shortness of breath subsided, although the general nervousness persists.

[1] Mora, J. M. *Surg. Gynec. Obst.*, 48: 123, 1929.

* From the Departments of Medicine and Surgery, Western Reserve Medical School, City Hospital, Cleveland.
Submitted for publication August 20, 1931.

# VASCULAR ORIGIN OF CONGENITAL TORTICOLLIS

## CASE REPORT*

HOWARD C. EDDY, M.D.

CLEVELAND, OHIO

THE final lesions in a long-standing case of secondary congenital torticollis are fibrosis and contracture in the sternocleidomastoid muscle. The deformities of the face and skull are the natural mechanical sequelae of the primary shortening of the sternocleidomastoid muscle. This paper presents a study of the anatomy and physiology of this muscle, and of the pathological changes encountered in an early case. Certain features deserve especial attention.

The sternocleidomastoid muscle arises from the sternum and clavicle by two heads. The medial head is a rounded fasciculus arising from the upper part of the anterior surface of the manubrium sterni. The clavicular head arises from the superior border and anterior surface of the medial third of the clavicle. The two heads are separated at their origins by a triangular space, but gradually fuse into a thick rounded muscle which is inserted by a strong tendon into the lateral surface of the mastoid process and into the lateral half of the superior nuchal line of the occipital bone. The sternocleidomastoid muscle is supplied by the eleventh cranial nerve and the second and third cervical nerves. The muscle is derived from three embryonic metameres and retains its arterial and venous blood supply as based upon the primary segmentation. The upper mastoid portion of the muscle is supplied by the superior sternomastoid artery which is a branch of the occipital artery. The venous return penetrates the deep aspect of the muscle to join the large veins. The sternal head of the muscle is supplied by the middle sternomastoid artery which takes origin from the superior thyroid artery. This artery follows along the posterior border of the sternal head, sending numerous branches into the head. The venous return parallels the artery. The clavicular head is supplied by the inferior sternomastoid artery, a branch from the thyreocervical trunk. The venous return may parallel the artery or return directly to the external jugular vein.

Nové-Josserand and Viannay[1] studied the circulation in the sternocleidomastoid of the stillborn fetus and demonstrated that the three systems of blood supply are independent and not connected by anastomosing channels. They further showed that extreme rotation of the head caused the tense sternocleidomastoid to compress the middle and inferior sternomastoid arteries so that they could not be injected. Middleton[1] has advanced the theory that the important factor is not arterial, but venous obstruction which might easily occur at parturition.

There are certain statistical correlations between the incidence of torticollis and the type of labor undergone. Plass[3] analyzed over 5000 vertex presentations at the Johns Hopkins Hospital and found 64 per cent left-sided positions and 36 per cent right-sided positions. Zweifel[4] in over 9000 vertex presentations found 71 per cent left-sided and 29 per cent right-sided positions. As the greater portion of the posterior positions will either rotate anteriorly or be rotated by the obstetrician, it means that, following the normal mechanism of labor, almost twice as many infants will be subjected to a pronounced torsion of the head to the left, followed by hyperextension of the neck as the body descends and the occiput snubs beneath the symphysis, as

* Submitted for publication September 23, 1931.

will be subjected to the strains incident upon the homologous position. As the normal mechanism for delivery of a left position tends to throw increased strain upon the right sternocleidomastoid, it is of interest to observe Hutter's[5] statistics which show a slight preponderance of right-sided torticollis. He has collected a series of 691 cases, 56.4 per cent of which were on the right. These figures are affected by the somewhat high incidence of torticollis following delivery from other positions than the vertex position. Of Middleton's[2] series of 64 cases of torticollis, 43 were first children and hence were probably subjected to a relatively prolonged second stage of labor. Of the remaining 21, 16 were difficult prolonged labors, cross-births or breech presentations. In a series of 54 cases of Erb's paralysis, a condition which is known to be associated with protracted labor and difficult delivery, 20 per cent exhibited a sternomastoid tumor.

In a large number of cases of torticollis there is a history of the sudden appearance of a sternomastoid tumor at about the end of the first month of life in an infant previously considered entirely normal. In a portion of these cases the tumor may be concealed by the short neck of the infant, but in many cases it seems definitely established that there is no onset of signs before the end of the first month of life.

Comparatively few operations or pathological studies have been reported for infants of one to two months. Von Lackum[6] has reported 3 cases which are of especial interest; 1 was a child five weeks of age, and the other 2 were eight weeks of age. In only 1 of these cases was there a history of a difficult breech delivery. In the first case a sternomastoid tumor was noticed soon after birth, in the other two it was first noticed at the end of one month. In all cases the tumor mass was immediately excised, and subsequent follow-up examination after an interval of months revealed a good anatomical and functional result. The pathological picture in these cases was substantially that which is to be more fully described later.

The essential pathological change seen in

Fig. 1. Old thrombosis of two veins and perivascular round cell infiltration. Hematoxylin and eosin. ×124.

the early sternomastoid tumor is an actively proliferating replacement fibrosis of striate muscle without evidence of inflammatory leucocytic infiltration or deposition of hematogenous pigment. The process is sharply delimited by the muscular sheath. An identical lesion has been produced in dogs by Middleton by applying separate ligatures to the venous return from the sartorius. These lesions produced experimentally have, as shown by his description and photomicrographs, no essential differential characters from the changes seen in sternomastoid tumors in human beings. He, therefore, advances the

hypothesis that the etiological factor in the production of sternomastoid tumor is temporary venous obstruction, perhaps followed by thrombosis, resulting from venous compression when the muscle is placed under unusual tension by prolonged torsion of the neck.

The patient upon whom this study is based was operated upon at the Lakeside Hospital by Dr. Elliott C. Cutler. The case is unusual in that it is one of the youngest ever reported, and because of the fact that in the microscopic section blood vessels are seen in which fibrosis and organization have not so far advanced toward cicatrization as to destroy the identity of the vessels. Numerous venous radicles contain organized thrombi, lesions which Middleton states have never been definitely identified in his cases.

## CASE SUMMARY

R. F., a white male of six weeks, a first child, was admitted to the Lakeside Hospital on March 12, 1928, with the complaint of a "bony" mass on the right side of the neck, first noticed when the child was one month of age. There was a history of low forceps delivery from a right occipito-anterior position, and the statement was made that the head was traumatized at birth. The history was otherwise unimportant except for the present illness. The mother stated that the child appeared normal at the time of birth. When the infant was one month old, the mother noticed a "bony" mass on the right side of his neck which was not painful on pressure. At the same time she noticed that the child held the head constantly to the left.

The physical examination revealed a well developed, well nourished male infant six weeks of age who held his head constantly rotated to the left and inclined toward the right shoulder. It was impossible even with gentle pressure to rotate the head to the right. The head was slightly flattened over the right parietal region, but showed no other abnormalities. The right sternocleidomastoid was resistant to stretching. A mass of cartilaginous consistency extended throughout its entirety and included both sternal and clavicular heads and stood out on the neck as a tumor mass $4 \times 1 \times 1$ cm. The eyes, ears, nose, and throat were negative. The thorax, heart, and lungs were normal. The abdomen showed a small umbilical hernia. The genitalia, extremities, and reflexes were normal. Laboratory findings: urine, negative; hemoglobin, 90 per cent; white blood corpuscles, 9200. Roentgenograms of the skull and cervical spine showed no definite evidence of pathological change.

On the second hospital day the right sternocleidomastoid was excised. The entire sternocleidomastoid appeared as a dense white fibrous structure. Upon separating the sternal and clavicular insertions there was slight bleeding from two points. In the upper portion of the muscle more patent blood vessels were encountered. The muscle was resected 1 cm. below the mastoid in an attempt to leave the trapezial portion of the eleventh nerve intact. On the second postoperative day the sutures were removed. The wound healed per primam, and at the time of discharge on the eleventh postoperative day the child moved his head from side to side with ease.

The child was seen in May, 1928, May, 1929, and February, 1931, in the Follow-up Clinic, and on these occasions the late results of operative treatment were reported to be excellent.

*Pathological Studies.* Culture: A portion of the muscle was placed on dextrose broth and ascitic agar, but no growth was obtained in forty-eight hours.

Gross description of sternomastoid tissue: The specimen consisted of an elongated piece of tissue, measuring $4 \times 1.5 \times 1$ cm. It was rather irregular in outline and of rubbery consistency. On section it was pearly white in color and homogeneous.

Histological Report: The specimen consisted of an irregular mass of fibromuscular tissue which was covered on two adjoining sides by a fibrous sheath suggesting a fascia layer or a capsule. Outside this sheath were several bundles of normal-appearing voluntary muscle as well as several small groups of striate muscle fibers which were the seat of interstitial fibrosis. Within the sheath the character of the tissue varied as the center of the specimen was approached. Immediately beneath the sheath the muscular elements predominated. The muscle bundles were cut in cross and longitudinal sections and were seen to be separated from one another by adult fibrous

connective tissue. Moving inward from the sheath the muscular elements became less prominent and toward the center the tissue consisted of very dense fibrous connective tissue which was especially rich in collagen fibrils. Even here, however, occasional isolated muscle cells were seen, and there was slight increase in number of muscle nuclei. Small groups of lymphocytes were encountered, but there was no diffuse infiltration. The tissue was treated with potassium ferrocyanide and hydrochloric acid and there was no evidence of hemosiderin. Several small blood vessels and nerves were incorporated in the fibrous connective tissue. The small arteries showed in many instances a marked intimal or medial proliferation with definite narrowing of the lumen. To a slight extent around the arteries, but more extensive around the veins, was a definite perivascular infiltration of lymphoid cells. The small veins showed slight thickening of their walls. Several showed in the lumina small dense acidophilic masses of fibrin intermingled with variable numbers of fibroblasts. By means of elastica stains it was found that these organizing thrombi were confined to veins and were not to be observed in arteries.

The histological findings would indicate the process to be in the nature of a fibrous connective tissue replacement of muscle following a degenerative change which was more marked in the center than at the edge. There was no evidence of active inflammation and yet the fibrosis was progressive. These changes as observed in a sternomastoid tumor removed from an infant of six weeks were consistent with Middleton's hypothesis that venous stagnation and thrombosis are the etiological factors in the formation of a sternomastoid tumor (Fig. 1).

## CONCLUSIONS

1. Anatomical peculiarities in the circulation of the sternocleidomastoid render it particularly liable to interference from strain upon the muscle when the neck is subjected to extreme torsion, as during parturition.

2. A preponderance of right-sided congenital torticollis is roughly correlated with the preponderance of left vertex positions. It is noteworthy that the normal mechanism of delivery in left vertex positions throws increased strain on the right sternomastoid muscle.

3. The presence of definite venous thrombi in the case reported here (findings not reported in any of Middleton's cases) lends support to Middleton's conclusion that the essential factor in the production of sternomastoid tumor of congenital torticollis is temporary venous occlusion at the time of parturition followed in at least certain cases by venous thrombosis.

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# COMPLETE LOSS OF FEMALE URETHRA & BLADDER FLOOR*

BASIL A. HAYES, M.D., F.A.C.S.

OKLAHOMA CITY, OKLA.

COMPLETE loss of the urethra is of comparatively rare occurrence and there are not many cases in the literature.

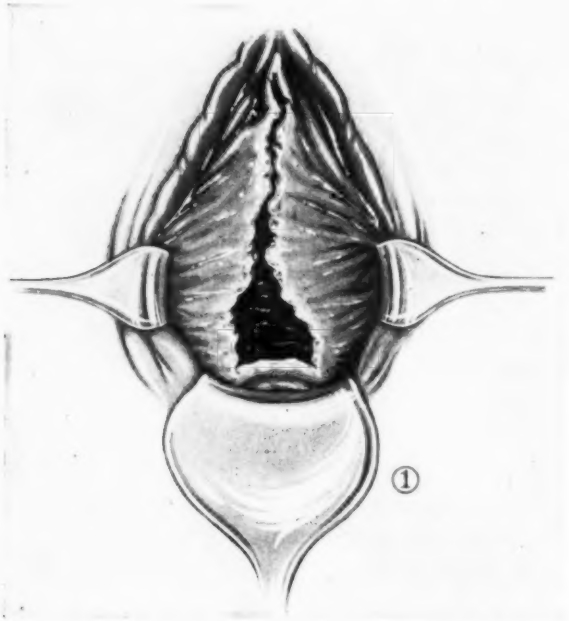


FIG. 1. Complete rupture of female urethra with loss of bladder floor. Note narrow rim of tissue in front of cervix and scarified edges of opening.

Noble states that he has heard Emmett say that in his large experience, although he had succeeded in six or seven cases in restoring the urethra, all of them were unsatisfactory and he would abandon further attempts. In both Noble's and Kelly's cases, pressure with a tampon or special pessary was necessary to insure control. Baker Brown seems to have had unusual success in three cases he has reported.

With these words George Gray Ward sums up his article in Lewis's "Surgery" on the subject of destruction of the female urethra. He reports 1 case of his own in which the defect consisted of a destruction of the under side of the urethra, including the neck of the bladder, where there was an opening into the bladder the size of a twenty-five cent piece. By turning a long flap upward from the base of the bladder and slipping it under a tunnel in the vestibule, he succeeded in constructing a serviceable urethra. His work was based upon the technique devised by Kelly, who reports 2 cases and quotes Noble as having operated upon another. In none of these 3 cases was urinary control established, and the patients had to wear pessaries to press the urethra together and prevent leakage. The method followed by Noble was to dissect up the labium minus on one side and slide it over the urethral trough, fastening it in place and allowing healing to occur. These 4 cases, with 3 others reported by Brown of London, comprise all that I can find in the literature.

In none of these cases where the details are given was there more than a destruction of the urethra with a small defect of the bladder. It is my privilege in this paper to report an eighth case successfully repaired, in which the injury was not only a destruction of the urethra but of virtually the entire base of the bladder as well.

## CASE REPORT

Mrs. P. M., aged twenty-four, University Hospital No. 53080, was operated upon in December 1928 in another state for "falling of the womb." After eighteen days in the hospital she went home. Two months later she had difficulty on urination and finally could not void for twenty-four hours. She was catheterized by her family physician, who told her that she was hysterical and would get better. She did not, however, and he taught her to catheterize herself. A few days afterward she returned to the hospital where she was told that she had inflammation of the bladder. After two weeks she was cystoscoped, and the

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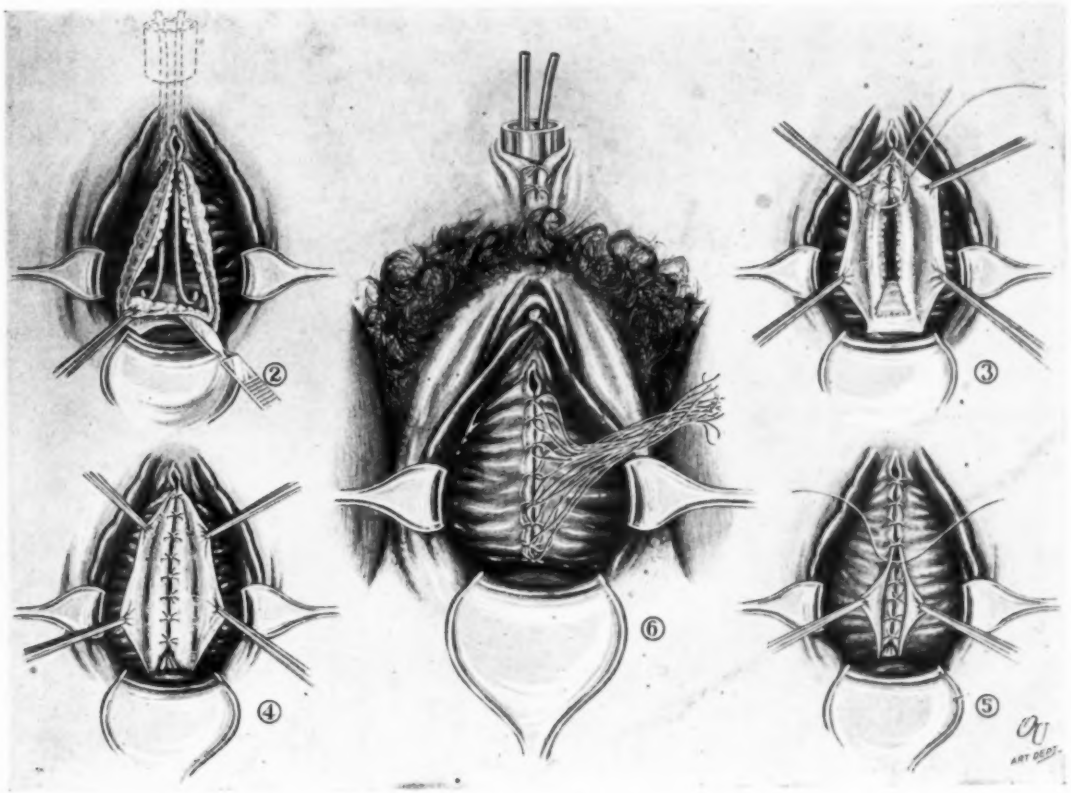
cystoscopist said that he saw a number of stones in the bladder; that these stones had eroded away the floor of the bladder until they were almost in the vagina; and that the manipulation of the instrument broke the thin wall through, causing a vesicovaginal fistula. After this accident the tissues about the vagina swelled enormously so that a tube had to be inserted into the vagina to allow the urine to escape. At this time also a suprapubic opening was made, through which eight stones were removed. Some weeks later, after she had regained her strength and courage, she was again operated upon for the purpose of repairing the vesicovaginal fistula. This was unsuccessful, and left a larger opening than before. Another attempt ended likewise, and she was dismissed as hopeless. After a number of months she came to Oklahoma City, where she tried to get help but failed. Finally she grew despondent and attempted suicide by taking lysol. She was rushed to the hospital. where proper treatment saved her life.




Figs. 2–6.

Fig. 2. Catheters have been passed to each kidney and their ends brought out through suprapubic wound. This wound is held widely open by large rubber tube drain. Lower dissection shows line of cleavage between bladder and vaginal wall.

Fig. 3. Dissection completed. Suturing begun with No. 1 chromic catgut, turning edges of bladder and urethra inward without tension.

Fig. 4. Second row of chromic sutures placed outside first row, rolling edges further in. A third row was placed in like manner, with slight tension.

Fig. 5. Placing first row of silkworm gut sutures through deep portion of vaginal flaps.

Fig. 6. Completed operation. Sutures left long for convenience in removing.

At this point I examined her and found that the entire urethra and floor of the bladder had sloughed out, leaving only a narrow rim of tissue about ½ in. wide just anterior to the cervix. On pressing the posterior vaginal wall backward and separating the labia one could look directly into the bladder cavity. Each ureteral orifice could be seen about ½ in. lateral and superior to the edge of the bladder opening. Urine trickled from the vagina continually, and in spite of pads, perfumes, etc., there was an odor of urine constantly about her.

At first thought it appeared that the proper thing to do was to transplant the ureters into the bowel, as had been suggested by her orifice to the opening in the bladder, skirting around this on each side and ending at the cervix, where a transverse incision joined the

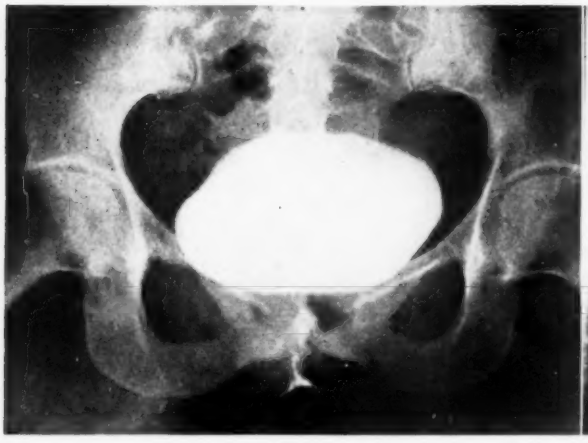


FIG. 7. Cystogram and urethrogram (antero-posterior view) two and one-half months after operation. Showing normal bladder outline and good urethral sphincter. Bladder was filled with 10 oz. of 8 per cent sodium iodide solution and urethra was injected with bismuth paste.

FIG. 8. Same as Fig. 7, except taken in Sims' position to show lateral view of reconstructed urethra.

previous doctors. This idea was concurred in by several consultants, who felt that no other plan would be feasible. After considering it for several days, however, I decided to make one more attempt at repair before resorting to such a drastic step as transplanting ureters. The patient was willing for anything, since she had fully decided to end her life unless I succeeded in repairing the defect.

*Operation:* On December 3, 1930, she was placed in a lithotomy position and the vagina prepared by scrubbing with alcohol. A weighted speculum was then inserted and the cervix uteri grasped with forceps and pulled outward. The edges of the bladder opening were retracted and the ureteral orifices showed up plainly. A No. 6 *x*-ray catheter was inserted in each and pushed upward until it reached the kidney. A suprapubic opening was then made in the bladder large enough to receive a rubber tube 1 in. in diameter. This was sewed in place and the wound closed in the usual way. The lower end of each ureteral catheter was turned upward and brought out through this rubber tube which was cut off ¾ in. above the skin, leaving only a stiff rubber ring holding the suprapubic opening well apart.

Two long incisions were then made parallel to each other and ¼ in. lateral to the remains of the urethra, extending from the external posterior ends. These incisions went through the vaginal mucosa and were outside the area of scar tissue. The bladder wall was then dissected loose from the vaginal mucosa for ½ in. or more on each side. This mobilization of tissue was continued along the side of the urethra until the medial edges of the paraurethral incisions could be turned inward and overlap each other slightly. The tissue in front of the cervix was thoroughly loosened, the line of cleavage between bladder and vaginal wall was found and the two were separated as far upward as appeared safe. By then turning the vaginal surface upward toward the bladder about one third of the bladder defect was filled.

The next step consisted of one row of chromic No. 1 catgut sutures, placed as close to the turned in edge of bladder and urethra as possible. The sutures were interrupted and were placed in the urethra first, continuing downward on the bladder as far as possible without producing tension on the tissues from side to side. It was found that this row could be carried to about ¾ in. of the cervix. At this point the turned up flap of vaginal wall was sewed into the opening, thus closing the entire bladder without tension. A second row of sutures was then placed exactly like the first, except that they were outside the first and turned the flaps inward a little farther. Still a third row was placed likewise, resulting in a perfectly water-proof closure of the

bladder and urethra, and bringing nearer together the dissected flaps of vaginal mucosa. Silkworm gut sutures were then placed through the bases of these flaps, drawing them together with slight tension (which naturally lessened any tension there might have been on the bladder wall inside). Since these flaps projected about ⅛ in. outside the sutures, there was ample surface for union which was not under tension. The silkworm sutures were left long and tied together in one bundle for convenience in removing. A gauze pad covered with vaseline was placed behind the cervix, lifting it and the suture line forward. Another gauze sponge was wrapped around the bundle of silkworm sutures to prevent irritation of the vestibule, and the patient was returned to bed.

*Postoperative Course:* The foot of the bed was elevated 6 in. and each ureteral catheter was placed in a bottle. A strip of adhesive held them in place on the patient as they came through the dressings. Fluids were restricted to 500 c.c. daily and food to 500 calories daily, for the purpose of lessening the amount of urinary secretion. After six hours the dressings were turned back and a rubber catheter gently lowered into the bladder and 100 c.c. of urine aspirated out, which had leaked down along side the ureteral catheters. This was repeated every two hours day and night, for the first week. It was soon found that the ureteral catheters were handling very little of the urine, hence on the third day they were removed. At no time did more than one third of the urine come through them. After the third day the bladder was gently flushed out with boric acid solution each time it was aspirated. Beyond an occasional temperamental outburst, which had to be handled tactfully by nurses, internes and surgeons, her progress was perfectly smooth. The gauze was changed in the vagina every three days, and a few sutures were removed on the tenth day. A few more were removed every two days until all were out by the sixteenth day. The wound healed by first intention except for a pinpoint opening next to the cervix, which yielded to one slight injection of silver nitrate. The suprapubic tube was left in until the eighteenth day, then was removed. The opening left by this was closed entirely on the thirty-fifth day. Prior to this I had slipped a small uterine probe through the newly made urethra and found it patent.

On the thirty-first day she developed a pain in the region of the right kidney and a fever of 100 to 103°F. Considering this to be a pyelitis, I persuaded her to allow me to cystoscope her, using a size twenty Brown-Buerger instrument. The interior of the bladder was still considerably inflamed and the infolded edges were raw and rough. I lost my courage and did not catheterize the ureters for fear of injuring the newly united tissues. She voided through the urethra on the thirty-fifth day and had perfect control. She told me at this time that her sensations of urination were perfectly normal, and as if she had never been incontinent. Her pyelitis slowly improved under fluids and alkalies and the bladder irritation improved until she could sleep all night without getting up. I cystoscoped her again on the fifty-seventh day, and found that the bladder had cleared up beautifully, the interior being perfectly smooth except for a small rough place about 1 cm. in diameter at the posterior end of the scar. She left the hospital two days afterward, completely healed, comfortable and perfectly continent. Two weeks later she came to my office, and I injected 6 oz. of 8 per cent sodium iodide solution in the bladder, then injected warm bismuth paste in the urethra for *x*-ray pictures. The bladder held these substances without the slightest distress or leakage. She is now working as a housemaid.

The problems presented by this case were twofold:

1. To repair the opening in the bladder and create a new urethra.
2. To establish a functioning sphincter.

The first of these was the more difficult because of ever-present urinary irritation and the large amount of scar tissue from previous operations. The urinary irritation was overcome by ureteral catheters, by raising the foot of the bed very high, thus causing such urine as did accumulate to roll backward into the fundus of the bladder, and by constant, persistent drainage every two hours day and night. To this was added the extra precaution of restricting both fluids and food so that there would be very little urine excreted. These postoperative measures undoubtedly contributed a great deal to the success of the undertaking.

The question of scar tissue was very difficult, but by going entirely outside of it and turning in flaps of healthy vaginal wall it was much easier to sew several rows of sutures without tension than it would have been otherwise. Perfectly free mobilization of the bladder wall was aimed at, regardless of how small the completed organ might be, hence wide dissection to each side was made. The urethra was handled in the same manner, turning in ample flaps and placing sutures Lembert-wise through only the outer surface so as to avoid injury to circulation. No tube of any kind was left in the urethra, as a stricture would have been preferable to a breaking down of the sutures. The flaps were rolled in by three rows of sutures, thus closing the lumen snugly and under very slight tension, which was later reinforced by pressure from the vaginal wall flaps.

The perfect sphincteric action can be attributed to the fact that the third row of sutures at the bladder neck was definitely placed in the bladder wall, thus bringing a ring of detrusor all around the opening. Since this muscle is normally under tonic contraction it acts like a rubber band around the urethra and keeps it closed until such time as increased hydraulic pressure inside the bladder forces it open.

## SUMMARY

A search of available literature shows but 7 reported cases of complete destruction of urethra. None of these was accompanied by complete rupture of bladder floor. In only 4 are details available and the results obtained were completely satisfactory in only 1 of these. In this one the bladder floor was present and could be used for turning a flap forward in the building of a new urethra.

To this list is added an eighth case in which the entire urethra and bladder floor have sloughed out. The repair was accomplished by free mobilization of the side walls and careful postoperative management. The result was perfect, both anatomically and functionally.

# DIVERTICULUM OF THE JEJUNUM*

## WITH CASE REPORT

SYDNEY K. BEIGLER, M.D., ARTHUR R. BLOOM, M.D., AND JOSEPH WRUBLE, M.D.

DETROIT, MICH.

JEJUNAL diverticula are sufficiently infrequent to warrant the report of this case in which the diagnosis was made by the roentgenologist (Dr. Bloom) and confirmed by operation.

### CASE REPORT

A male, twenty-nine years of age, was admitted to the hospital on March 9, 1931 complaining of epigastric pain. His past and family history was essentially unimportant. His present illness dates back to about one and one-half years ago at which time he began to have epigastric pain usually localized to the left of the midline. The pain, at times, was quite severe and would come on about one to two hours after meals. Accompanying the pain there was always nausea and eructation of gas. Soda would give him relief but only temporarily. The attacks became frequent and after consulting several physicians he was placed on an ulcer diet which modified his symptoms to some extent for short periods but they always recurred. Gastrointestinal *x*-ray studies failed to reveal any organic lesion and the patient was again placed on an ulcer diet, without any apparent improvement. At this time a more careful and thorough *x*-ray investigation of the gastrointestinal tract (by Dr. Bloom) revealed a diverticulum of the jejunum.

The laboratory examination showed a normal blood and urine and his Wassermann reaction was negative.

After several days of hospital observation, the patient was operated upon. Through a right rectus incision the abdominal viscera were explored and found to be negative except for a diverticulum of the jejunum situated about 40 cm. from the duodeno-jejunal junction. It was located on the mesenteric border surrounded by many firm adhesions which bound the diverticulum down to the mesentery. The outer wall was slightly inflamed and in conjunction with the presence of the adhesions indicated an inflammatory process in the sac. The adhesions were severed and the diverticulum isolated throughout and was found to be about 3 cm. long and 2.5 cm. wide. This diverticulum was resected through a longitudinal elliptical incision and sutured transversely. The appendix was removed secondarily.

PATHOLOGICAL REPORT: "The diverticulum is lined with intestinal mucosa with high villi and small glands. It is congested, infiltrated with numerous lymphocytes, a few eosinophiles and numerous small hemorrhages. The muscle coats are extremely thin and the vessels of the peritoneal layer are markedly distended. *Diagnosis:* Early acute diverticulitis."

The patient made an uneventful postoperative recovery and was discharged in excellent condition. Six months after the operation we find the patient in good health, entirely free from all of the symptoms which he had previous to the operation. At present he has had no food discrepancy whatsoever.

### DISCUSSION

Diverticulum of the gastrointestinal tract is not an infrequent finding. Meckel's diverticulum is a well-known operative finding. Next in frequency they are to be found in the duodenum and large intestine, particularly the sigmoid. Diverticulum of the jejunum, however, is a very infrequent finding. A thorough investigation of the literature reveals only 38 cases, most of which were found at necropsy. Out of this number only 9 were diagnosed preoperatively and confirmed by operation. Our own case increases the number to 10. Several cases are on record where a diagnosis of diverticulum of the jejunum was made by *x*-rays findings but the diagnosis was not confirmed either by operation or necropsy. Case in 1920 reported 5 cases where a

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diagnosis of jejunal diverticulum was established roentgenologically but only 2 of which came to operation and the diagnosis confirmed. The non-operative patients, however, presented the typical symptoms and the *x*-ray findings were so characteristic that there was no doubt in his mind as to the correctness of his diagnosis.

Diverticula of the jejunum may be single or multiple but more frequently they are single. They may occur at any age although Rothschild claims that they are more likely to be found in individuals past fifty. There seems to be considerable discussion and discrepancy as to whether they are acquired or congenital. Those who contend that they are congenital point out the fact that other anomalies of the intestinal tract are found to coexist, but in most cases we feel that they are acquired and that they are due either to a natural weakness of the bowel wall or that the weakness is artificially created by inflammation, ulceration, increased intestinal pressure or other pathological processes.

The symptoms presented vary a great deal. They may be absent entirely as evidenced by the fact that most of the jejunal diverticula are found accidentally. If symptoms are present they are essentially the same as those of a duodenal ulcer. In fact all of the cases reported have been treated for duodenal ulcer before discovery was made that a diverticulum existed. The symptoms consist largely of gastric distress one to two hours after meals. There is considerable nausea and occasionally vomiting. The pain is marked at times and located to the left of the midline in the epigastric region. Palpation of this area will reveal a tender spot and that is usually the location of the diverticulum. If the diverticulum has an inflammatory process the tenderness will be more severe and permanent. The symptoms produced depend a great deal upon the size of the orifice of the diverticulum. If the orifice is large, the diverticulum will be able to empty itself of all the food particles which enter. If it is small, the food material will remain within the diverticulum and undergo decomposition, resulting in inflammation and antiperistalsis, the caustive agents in producing the symptoms. The course of the jejunal diverticula also resembles very much that of duodenal ulcer in that they respond very favorably to a medical treatment for a period of one to three years but after that time the symptoms become more pronounced and one is forced to resort to surgical interference.

The diagnosis is never established clinically, but roentgenologically. The roentgenologist must be very observant and if he sees a suggestive lesion must be willing to repeat the examination several times before he discharges the patient. Fortunately in the past ten years with the marked improvement of the *x*-ray technique and diagnosis, a number of cases have been diagnosed by the radiologist which formerly would have been missed.

The treatment should be surgical as soon as the diagnosis is established. If the diverticulosis is multiple it may be necessary to resect part of the jejunum or to perform a low gastroenterostomy. If single, resection of the diverticulum offers the best results. In the reported case where the diverticulum was resected, we find the patient six months after the operation to be free of any symptoms.

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# MIGRATORY COLON

## CASE REPORT*

ROBERT C. PENDERGRASS, M.D.

AMERICUS, GA.

WHILE anomalies of the colon have been so frequently observed and reported as to make them commonplace, the following case report is offered because it demonstrates an unusual mobility of the colon and the value of prolonging colonic studies through the forty-eight hour and enema observations.

FIG. 1. Dilated duodenal bulb and almost vertical duodenal loop.

CASE No. 18213. White female, aged sixty-two. Referred by Dr. E. B. Anderson.

*Chief Complaint:* Shortness of breath, spitting of blood, and nausea.

*History:* For several months she has had occasional attacks of nausea and gas formation. One month ago, she became nauseated and vomited a small amount of blood. This has continued at intervals for the past two weeks. She tires easily on exertion. There was no history of abdominal colics of any kind.

*Physical examination* showed a slightly dyspneic, elderly female, with a small epithelioma on the left lower lip, cardiac hypertrophy and arrhythmia, gaseous distention of the abdomen, and generalized tenderness, with a suggestion of a movable mass in the left lower quadrant, which appeared to be connected with the bowel. Blood pressure 170/120.

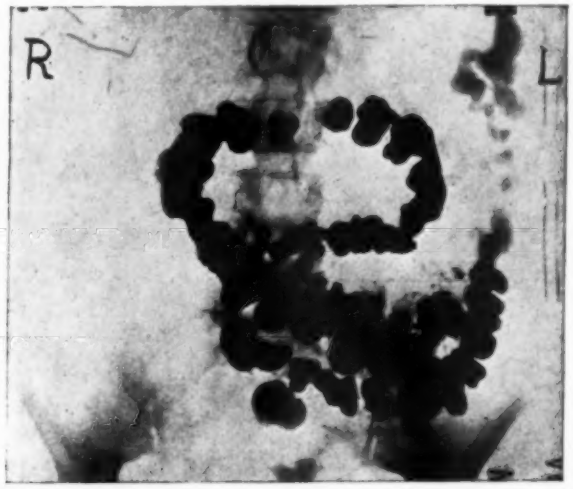


FIG. 2. Twenty-four hour film, showing cecum and ascending colon on left.

While the physical and clinical findings pointed to cardiac pathology with abdominal manifestations, she was referred for roentgen examination of the gastrointestinal tract in order to rule out a neoplasm and identify the mass in the left lower abdomen.

The esophagus and stomach showed no lesions, but the duodenal bulb was moderately dilated and the usual c-shape of the duodenal loop was replaced by an almost vertical position of the second and third portions. At the six and twenty-four hour observations the cecum and proximal colon were found in the left lower abdomen, but at forty-eight hours had resumed their normal position on the right. There was

* Submitted for publication September 24, 1931.

redundancy of the transverse colon. A barium enema demonstrated the right colon in normal position, with redundant coils of the transverse colon and sigmoid. The usual sharp angle of the hepatic flexure was absent.

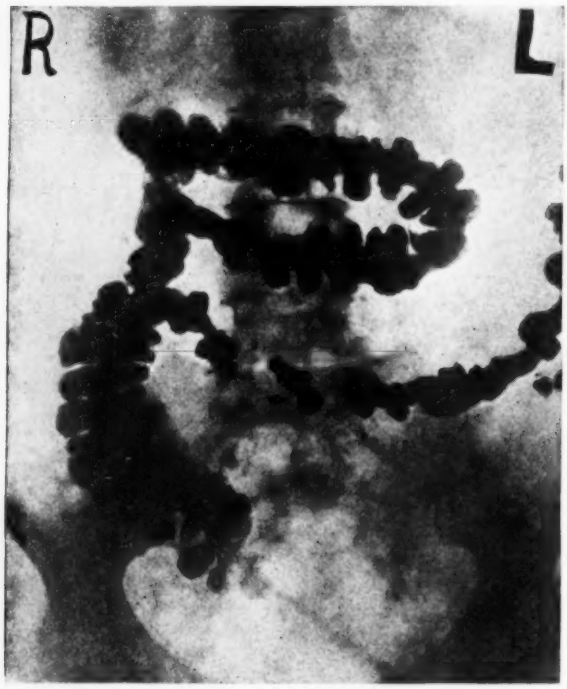


Fig. 3. Forty-eight hour film, showing normal position of cecum.

Had the roentgen observations ended at twenty-four hours a diagnosis of fixed non-rotation of the right colon would have been returned. Instead, the later observation demonstrated an unusual colonic mobility, with transitory migration of the right colon into the left abdomen, presumptive evidence of an unusually long colonic mesentery. In the event of an attack of appendicitis, localization of pain might occur almost anywhere in the abdomen. Fluoroscopic observation showed the suspected mass in the left lower abdomen to be caused by the distended cecum during its migration to the left.

Fig. 4. Barium enema. Film showing normal position, with large sigmoid coils.

The anomalous position of the duodenum illustrates a partial non-rotation, and it is likely that there is also a long duodenal mesentery.

It is interesting to note that these intestinal anomalies had existed for sixty-two years without producing any noticeable symptoms until cardiac disease supervened.

# EFFECT ON THE KNEE OF A SHORTENED GASTROCNEMIUS MUSCLE*

JOHN JOSEPH NUTT, M.D., F.A.C.S.

NEW YORK CITY

THE number of cases in which I am consulted where a diagnosis has been made of chronic synovitis, arthritis or internal derangement and where the primary etiological factor has been interference with the normal mechanism of the knee, due to a shortened gastrocnemius muscle, is steadily increasing.

The greatest difficulty arises in differentiating between limited motion as an etiological factor and as a result of or concomitant with disease or injury. The gastrocnemius muscle when of normal length, with the knee in extension, permits of dorsal flexion at the ankle to 85 degrees or less. If the muscle is shorter than normal and the knee is straight, dorsal flexion can be obtained to only 90 or 100 degrees; or dorsal flexion to its normal extent may be obtained by flexing the knee, thus bringing the heads of the muscle above the femoral condyles closer to the insertion of the tendon into the os calcis. So, if the muscle is short and the foot is used normally in walking, the knee is not fully extended. The knee is in its strongest position when fully extended. When slightly flexed, the internal lateral ligament is relaxed, permitting abduction and then a ligamentous strain, the antero-posterior plane containing the center of gravity is slightly mesial to the midline of the astragalus and the transverse plane containing the center of gravity is slightly anterior to the normal weight-bearing line of the tibia, so that excessive muscular effort is necessary to support the body at the knee and there is a tendency to strain of the internal lateral ligament, to displacement of the semilunar cartilage and to a general strain of all the structures about the knee. The vulnerability of the joint lessens its resistance to all forms of trauma, minute as well as gross, and to other arthritic conditions, rheumatic and infectious.

It is very often difficult to evaluate the presence of the shortened gastrocnemius in connection with other etiological factors; but if Nature limits extension it is well to follow her directions and put it outside the power of the patient to voluntarily or involuntarily move the knee through a greater arc than comfort allows. Whether the case is one of internal derangement, chronic synovitis or arthritis from any origin, this rule should usually be followed. It is a much better one than that of absolute immobilization, if Nature makes no protest to a limited movement.

This can be accomplished by the use of a peg-stop brace. A long outside bar extends from the foot plate to the great trochanter, with joints at the ankle and knee, and an inner bar extends from mid-calf to the groin, with a joint at the knee. These two bars are united by posterior bands at calf and thigh and straps over the leg and thigh. The inner joint at the knee is free. The outer one is so made that a screw-peg prevents full extension. This peg can be screwed up or down to regulate the range of movement. It should limit extension shortly before movement at the knee is limited by spasm or causes pain. This limitation of extension also prevents the rotation which takes place at the end of extension. With such a brace the patient can safely do anything which the brace permits. If it is properly fitted he will be able to kick out freely, the peg stopping movement before apprehension is felt.

After the knee symptoms have disappeared, if the gastrocnemius is still shortened, the traction shoe will correct the condition if dorsal flexion to 95 degrees is possible. Otherwise a lengthening of the tendo Achillis is necessary.

* Submitted for publication August 17, 1931.

# NEW INSTRUMENTS

## A WALKING CAST

### FOR AFFECTIONS OF THE LOWER LEG*

LESLIE V. RUSH, M.D., AND H. LOWRY RUSH, M.D.

MERIDIAN, MISS.

THE peg leg cast of Dr. L. Roeren of Suchteln, Germany, described by Dr. W. P. Blount of Milwaukee[1] for use in the treatment of coxa plana has suggested to us a cast on the same principle which is most useful for the ambulatory treatment of fractures and other affections of the lower leg. This cast, however, is not used by us in fractures of the upper third of the tibia.

FIG. 1. Walking cast completed.

In fractures of the tibia and fibula reduction is accomplished and maintained on the fracture table with the knee flexed to a 90 degree angle. The upper third of the thigh and the distal third of the foot are encircled with stockinette. A thin layer of sheet wadding is applied to the foot, leg and thigh. A thin layer of felt is placed over the entire anterior surface of the tibia and a thick felt pad is placed over the anterior surface of the knee, extending well down below the tubercle of the tibia. A plaster cast is applied from the upper third of the thigh to the toes. The stockinette is turned back over each extremity of the cast and fixed with two or three turns of plaster bandage.

After the plaster has set the upper fourth or third of a crutch is sawed off, the two upright pieces are sprung over the medial and lateral aspects, respectively, of the cast and incorporated with several more turns of plaster (Fig. 1). It is usually necessary to move the cross bar of the crutch downward a few inches so that the peg leg will be the same length as that of the sound leg. The cast is most comfortable.

[1] *J. Bone & Joint Surg.*, Jan. 1931.

* Submitted for publication August 10, 1931

# URETHRAL AND VESICAL ASPIRATOR*

H. DAWSON FURNISS, M.D., F.A.C.S.

NEW YORK

THIS aspirator is made of tubing, the outside diameter of which is 2.5 mm. It measures 18 cm. from the tip to the bend. The shell at the distal tip is 4.7 mm. in diameter, and 2.5 cm. long. It is built on the principle of the Poole aspirator.

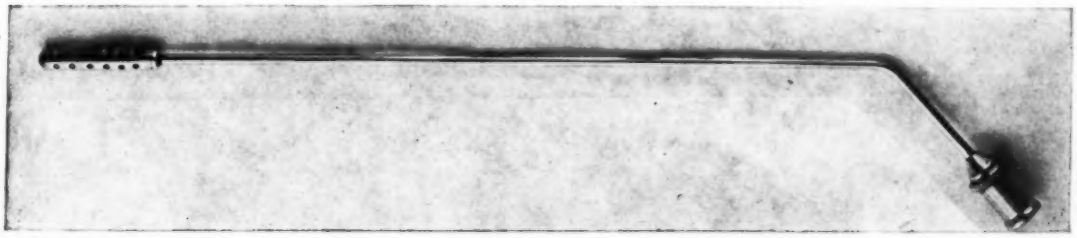

FIG. 1.

The small tube extends almost the length of the shell, which has many perforations; these prevent damage to the bladder and urethral mucosa, for it cannot be sucked into any of the holes as long as one or more holes remain uncovered. The distal end is fashioned so that it may be connected to a bulb, or to a suction apparatus, either by a slip joint connection or by placing the tubing or bulb over the flared portion. The shell may be removed for cleansing.

I have found its greatest value in the treatment of urethritis in the female; before its adoption it was necessary to have the patient in the knee-chest posture in order to get a well dried urethra to which to make topical applications.

In use I have allowed the tip to be in the bladder, as I withdrew the endoscope into and past the sphincter, without any fear that mucosal damage would result from suction.

* Submitted for publication April 16, 1931.

# INSTRUMENT FOR ELEVATING OF THE NEWBORN CRANIAL DEPRESSIONS*

JEFFERSON BROWDER, M.D.

BROOKLYN, N. Y.

THE ease with which the newborn head moulds during birth precludes frequent depressions of the flat skull bones. In some instances undue force is brought to bear on a local area with a resultant impression which may or may not be associated with fissure fracture. Such type of injury may be due to a deformed pelvis, an unusually large promontory of the sacrum, or the obstetrician's forceps. There are two common types of depressions, cup-shaped and groove. The former occurs more often in the frontal bones whereas the latter is seen in the parietal areas.

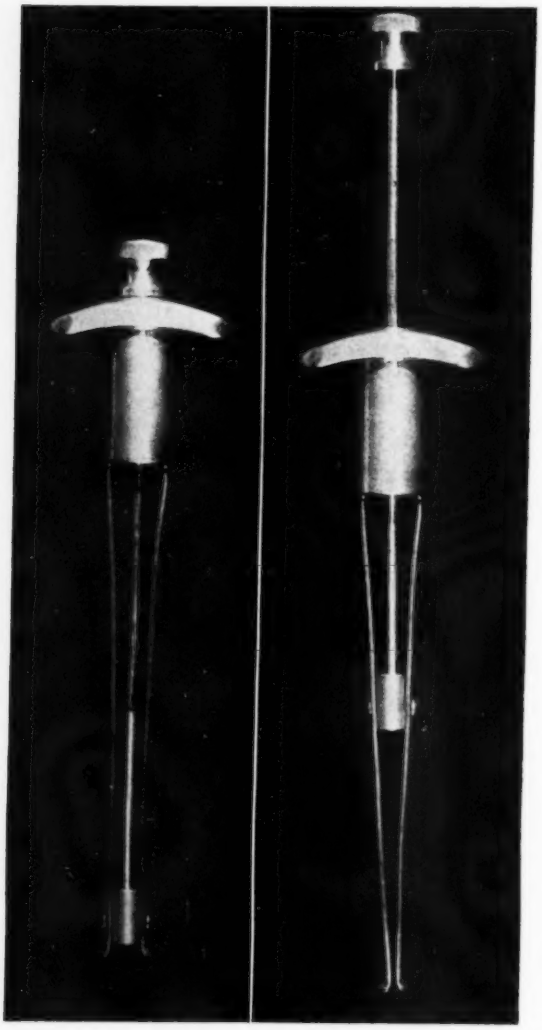

FIG. 1. Photograph of instrument.

FIG. 2. Example of type of lesion which may require open operative elevation.

In instances where the depression is an indentation of a portion of one of the flexible cranial bones and unassociated with a fissure fracture, one may by properly applied pressure convert the concave area into a normal convex surface. When such manipulation fails to restore the normal contour of the skull the condition can be successfully treated only by open operation.

Several types of instruments have been devised for this procedure, each aiming at

* Submitted for publication November 4, 1931.

simplifying the operation, but many are unsafe owing to the danger of injury to a cortical vessel. Because of the inadequacy of these instruments the author has devised a simple type of elevator which is both safe and satisfactory.

A brief description of the operative steps are as follows:

1. Under local anesthesia make a 3 cm. incision directly over the area of maximum depression.
2. Insert mechanical retractors which will also control bleeding.
3. Make a U-shaped incision in the periosteum, reflecting the free portion.
4. Burr opening in the skull just large enough to admit elevator tips.
5. Free dura about bony opening.
6. Insert elevator and push the spreading plunger downward.
7. Slowly apply traction until depressed bone is elevated.
8. Cover the bony opening with the reflected portion of periosteum and close the wound.

The advantages of this method are that the procedure can be performed in about ten minutes; every step is under visual control; the bone edges are not split as often occurs in using a hook, and the dura is not opened.

The resultant cranial opening is negligible and at the end of one year one cannot palpate this small defect.

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# EDITORIALS

## OBSTETRIC MORTALITY

FOR many years obstetricians have been concerned with the high mortality rate in obstetrics in the United States. A large literature has accumulated on this subject. Many cure-alls have been suggested.

Probably the greatest stride in the right direction resulted from the White House Conference on Child Health and Protection. For those who did not attend this conference a small book on Obstetric Education,[1] being the reports of the subcommittees on obstetric teaching and education, and that on education of physicians, which includes undergraduate and graduate education, has been published.

To those interested in this wide subject we heartly recommend this book. It is so full of meaty suggestions, constructive criticism and ways for improvement that the best we can do is to quote some of the more pertinent sentences which left their impression.

There have been and still are too few well organized women's clinics in connection with medical schools to give the necessary training and experience to medical students, to say nothing of the dearth of facilities for developing specialists in this field. . . . There are three major problems in obstetric training and education from the medical standpoint: (1)

[1] Obstetric Education. A publication of the White House Conference. N. Y., Century, 1932.

adequate discipline of the undergraduate student; (2) postgraduate training, and (3) graduate instruction. . . . In so far as obstetrics is concerned, the majority of students at the time of graduation are not qualified to assume responsibilities of caring for maternity cases. . . . We feel that an interneship with an adequate maternity service should be required, but whether the state or school should make this training obligatory, may be a debatable question. . . . The best type of physician never completes his education. He is always moving forward. We feel that, if the recommendations of the committees on undergraduate and graduate education of medical students were carried out, that there would be real progress in obstetric practice, with marked lessening of maternal, fetal, neonatal, and infant morbidity and mortality. . . . The bed accommodation in general hospitals is still very inadequate for teaching purposes, and the time devoted to this branch of medicine is too short. As a subject of instruction midwifery should rank equally with medicine and surgery. . . . The Committee can see no justification for the practice of permitting students, unaccompanied by a competent instructor, to deliver women in their homes. . . . In one hospital with 867 deliveries, 644, or 74.3 per cent, had labor terminated by forceps, version or cesarean section. This hospital is on the list of hospitals approved for internships and had six interns. . . . Our maternal mortality rate exceeds that of any and all continental countries: it exceeds that of Canada and some of the republics of South America—in short, it is one of the highest in the civilized world. We could go far in correcting this disgraceful state of affairs if our teaching institutions would provide adequate facilities for clinical instruction in obstetrics. . . . The American Gynecological Society, the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, the Section on Obstetrics, Gynecology and Abdominal Surgery of the American Medical Association are uniting in making overtures to the Council on Medical Education for a larger recognition of obstetrics in the curricula of our medical schools. *As yet they have not received satisfactory consideration from the council.* [Italics ours. Ed.] The application of the basic sciences to obstetrics can only be satisfactorily taught by a qualified obstetrician. . . . The Committee would emphasize the importance of a resident maternity service for undergraduate and graduates. A well ordered maternity service with sufficient clinical material, is the *sine qua non* of the clinical teaching of obstetrics. There is no adequate substitute. The ideal would be a detached maternity hospital in close proximity to the university hospital and under university control.

The White House Conference is over and the reports of its meetings are being filed away for future study by those who are sufficiently interested in the subject. The cheering is over, as it were. We wonder if those in authority will heed the valuable and practical suggestions offered, and see that they are made effective. We fear that it will result in causing a lot of talk at one time, printed pamphlets on dusty shelves, and that one day, in the distant future, some one will discover the obstetric maternal mortality in the United States is a disgrace to any civilized nation—and start the agitation all over again. We base our pessimism on "water that has gone over the dam."

T. S. W.

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# AMERICAN PHYSICIANS

## CASPAR WISTAR

CASPAR WISTAR, whose parents were of German extraction, was born in Philadelphia, September 13, 1761. His grandfather founded the first glass works in this country at Salem, N. J. The Wistars were Quakers and Caspar as a boy went to Friends' School, founded by William Penn.

It is said that young Wistar acquired a desire to study medicine during the battle of Germantown on October 4, 1777, at which he helped to care for the wounded. He became a private pupil of John Redman and worked with John Jones. At the same time he attended the lectures of Drs. Morgan, Shippen, Rush and Kuhn at the newly organized Medical School of Philadelphia. He attained the degree of Bachelor of Medicine (1782) and then went to England for a year. From there he went to Edinburgh and in 1786 received his degree of Doctor of Medicine.

He returned to Philadelphia, where Dr. Jones was then the foremost surgeon. He took Wistar under his wing and the latter was appointed physician to the Philadelphia Dispensary, and in 1789 to the professorship of chemistry and physiology in the College of Philadelphia. He was physician to the Pennsylvania Hospital from 1793 to 1810. Also, he became a Fellow of the College of Physicians.

Due greatly to Wistar's efforts the medical school connected with the University of Pennsylvania and the College of Philadelphia were united. After the consolidation he was associated with William Shippen as Adjunct Professor of Anatomy, Midwifery and Surgery in the University of Pennsylvania. Later surgery and midwifery became separate departments. After Shippen's death (1808) Wistar was made Professor of Anatomy. He was a teacher of parts. He published a "System of Anatomy" designed to be a textbook for his classes. It was a good work. He published several memoirs in the *Transactions of the American Philosophical Society*. He made a notable contribution to the anatomy of the ethmoid bone.

In 1788 he married Isabella Marshall of Philadelphia, who died two years later. In 1798 he married Elizabeth Mifflin. By this marriage there were several children.

Wistar played an active part in the cultured society of Philadelphia. "His house was the weekly resort of the literati of the city of Philadelphia." In 1813 he was the successor of Benjamin Rush as president of the Society for the Abolition of Slavery. In 1816 he became president of the American Philosophical Society.

Caspar Wistar died in Philadelphia on January 22, 1818.

T. S. W.

CASPAR WISTAR

[1760-1818]



*The American Journal of Surgery*
N. S. Vol. XVII, July, 1932

[From Fernelius' Universa Medicina, Geneva, 1679.]

# BOOKSHELF BROWSING

## THE RENAISSANCE AND SERVETUS

BEN WOLEPOR, M.D.

MONTREAL, CANADA

### THE RENAISSANCE

THE Martyrs of Rodin walk in a magic circle, totally unaware of each other; a band of mystics laden with chains that would bind them to the earth they ignore. The noose encircles their necks, but they forge on relentlessly, grouped in a solidarity that confounds mankind. Several stare at the heavens; others regard the ground, but it is with a veiled glance, for their thoughts lie deep within. They are the dreamers who would bring heaven to earth although the road they traverse leads to the scaffold. They have been burnt by slow fire, stoned by the mob and broken on the wheel, but they renew their numbers miraculously and each age sees their successors. They are truly the sons of God. A valiant physician, Michael Servetus, was one of them.

Farel accompanied him on the death march, trotting amiably by his side; the honest, stupid Farel who innocently asked Servetus, "Why do you cry, 'My God, My God?'" To whom Servetus turned bewildered eyes and said, "On whom else shall I call?" Farel was Calvin's friend and the latter had plotted Servetus' death. He succeeded in making him immortal. Farel turned to the crowd following Servetus and remarked, "He still calls on God; had he not been led astray he might have been a good man." When they reached the place of execution Servetus was bound to the stake by several turns of an iron chain; his neck was confined in a similar manner by rope. The crowd then reenacted a scene made memorable ages ago by crowning Servetus with a crown of straw and green twigs; for the hearts of men are slow to change. The torch was then applied and the darting flames reached for his face, drawing a cry of agony from the man. The crowd sickened of its sport and began heaping the faggots about Servetus, to hasten his death, but the wood was green and he suffered for half an hour, before death eased him of his pain and took him to regions where metaphysics are of little concern and men no longer torment one another because of divergent beliefs. His silence was broken once before death when he cried aloud to God to have pity upon him, but only the crackling of the flames responded.

The twentieth century finds difficulty in understanding the sixteenth. Four hundred years have placed a mighty, almost

impassable gap between the two. We have seen a boy fly across the Atlantic, observed railroads encircle the globe, sent expeditions into the Gobi to look for prehistoric man and unearth the dinosaur; watched aeroplanes dart about in the sun and have heard cannon hurl shells at Paris seventy-five miles away. New words have crept into the dictionary, Proletariat, Bourgeoisie; mighty nations are trying experiments that terrify mankind. Poverty, war is to be abolished. Men are forgetting heaven or else trying to bring it to earth. They no longer ask the number of angels that can stand on a needle point. They no longer believe in angels. They have gone into the discard with Apollo, Jove and Minerva. New gods have arisen, Production, Wheat and Cotton. Standardization is the cry of the day and the Machine rules. We know the planet which we inhabit, we have chartered its far-flung domains; it is no longer the thing of mystery and dread of the sixteenth century. We speak of relativity and light, economics and Babe Ruth. We feel enlightened and applaud Bernard Shaw but the sixteenth century would find us an earthy, alien crowd. They produced Erasmus and Sir Thomas More, Calvin and Servetus. They may have burnt the latter but he could never have been born in the twentieth century. The soil would have stifled him. We send our mystics to a sanatorium and an interne investigates their mental processes.

Servetus was a product of the sixteenth century, bearing the fruit of its advantages and disabilities. A brilliant physiologist, he refuted Galen in the realm of physiology and applied this fearless attitude to theology but found to his cost that faith was more important a factor in this sphere than critical investigation, and following the precepts of other institutions, the theologians destroyed the rebel who would undermine their structure. He was born of a distinguished family in Villaneuva, in the kingdom of Navarre, in 1509. His family had been jurists for generations. He was built slenderly; his forehead was narrow at the temples but lofty, his eyes were those of the dreamer, the man who though he treads the earth, dwells on the stars. Realizing his inward bent, his parents sent him to a neighboring seminary, believing that his career was that of priest. Like so many others of the fraternity of genius, the boy was precocious and also preternaturally pious. He did not complete his course at the seminary because of his inherent rebellious spirit. It was not a matter of religious belief (he was to die of excessive piousness) but merely that of self-assertion. He would believe earnestly in God but in his own way and the sixteenth century regarded individuality in religious opinion as a crime worthy of death by fire; a death, which the dual personality of Servetus, made up of rashness and evasion, escaped for years only to fall victim at last to his foes.

A creed is not evolved overnight. It must undergo gestation and delivery before emerging upon the world. The beginning of the sixteenth century was a stormy period. The brewing of religious thunder was heard, which gathered momentum until the very skies rocked and blazed with the heretical denunciations of Luther. The Pagans had come back to earth and brought their gods. Minerva, Goddess of Wisdom, attended the Revival of Letters and the Renaissance ushered in the advent of the Reformation. The Renaissance depended in large part upon the revival of learning. The latter was due to the social progress of North Italian communities; accompanying zest for learning was a natural desire for aesthetic development. Patriotism drank deeply at the font of ancient Rome; grace, symmetry, fullness of spirit, emotional outlets were sought and found in ancient art.

The minds of men were restless; the medieval period was far from the dreary void it is pictured to be; fine minds were merely dormant, not dead, and they awakened from their prolonged sleep to seize eagerly upon the treasures of the past.

Hungry for spiritual exploitation, they seized the ancient treasures of Rome and entered into a fuller and riper world. The creed of asceticism was doomed. The body was no longer reviled as food for worms; it was a noble creation which had enchanted the ancients and was to bewitch the moderns. The age was ripe for conquest, and Petrarch, the leader of the Quattrocento, fell under the domination of Virgil. The finest spirits of the age yearned to absorb a whole glorious civilization, that of Rome; a consuming desire and one that was to spell the doom of the Middle Ages and to produce Erasmus, Voltaire, science and modern scepticism.

A poet, Francis Petrarch, was to be the dawn of a new age, that of intellectual enlightenment. The Medieval Church had stressed submission; the body was dust, its desires unworthy. Men marked time on this earth and only began to live when they discarded the earthly mold and entered Paradise. Teachers arose who were dissentient beings; who stressed the humanistic note. "Knowledge," they cried, "is only desirable in proportion to the use that can be publicly made of it." Social welfare was considered and not the isolated, human soul, enclosed in a cloister, intent on its own salvation. "Wisdom," they proclaimed, "must be broadcast and not hoarded."

Vittorino selected from ancient literature and moral teaching all that to him seemed ennobling. He stressed the Christian desire for inner harmony, yet included in his vast educational scheme the corollary of aesthetic satisfaction; sought for the tranquillity that results from the study of the beautiful in art and music; grace, trained activity was emphasized. A career, he felt, should be preceded by a broad cultural training; to acquire judgment, wisdom and integrity one must have the background of a liberal education, which the ancients alone could impart. Christianity, the offspring of Judaism, was to be mellowed and matured by an infusion of Paganism. The Greeks were just as important in the scheme of things as the Hebrews. Socrates had treasures to impart of which Moses was unaware. Vittorino trained captains of worth, able ecclesiastics, distinguished teachers and administrators. His age did not see in him the destroyers of their taboos. He was, however, one of the militant band which was to plunge Europe into religious wars that would cause blood to flow like water and make both Goethe and Voltaire exclaim upon the wanton strife that arrested progress for generations. But birth is always accompanied by pain and mighty oaks fall so that saplings may reach to the light.

Guarius Veronese, another great teacher, felt that in the study of letters man would forge to higher things. His sojourn in Constantinople, the very center of Greek culture, his constant study of its ancient literature, gave him an impulse that was not to be denied. He became professor of Greek at the Studio of Florence and put manuals of Greek and Latin grammar into circulation. The influence of Guarius caused the evolution of a brilliant center of humanism, the University of Ferrara.

Leo Battiste Alberti held that wisdom should be strewn with full hands along the highroads of the world for all to gather according to their inclination and capacity. He was opposed to the doctrine of the body's worthlessness and to asceticism. "The chief virtue of the mind," he cried, "is a restless curiosity, a desire to absorb truth consequential to this factor." "Man," he claims, "differs from the beast because of his insatiable desire to know the cause of things." It remained for Rudolph Agricola to transfer the torch that cast a brilliant light, from Italy to Northern Europe. The shadows were dark but the flame of learning would dispel them. A brilliant star was to appear in the sky; Erasmus, the tireless scholar who attacked the very citadels of faith amidst the clamoring of outraged monks. "You are destroying the church," they cried. "I am only correcting errors," he smiled. They knew what he was doing, this repre-

sentative of Lucifer, the arch rebel. They saw the handwriting on the wall and they could spell therein the names of Luther and Voltaire. Erasmus escaped the fate of the heretic because of his consummate cunning, the lore of an old fox. His friend, Sir Thomas More, said of him, "Erasmus quotes facts, he doesn't express his opinions." Thus the compeer of Reuchlin evaded the stake.

Reuchlin introduced the study of Hebrew and Greek into Germany and created modern biblical criticism. Erasmus, with the brilliancy and erudition that made him the friend of popes, Sir Thomas More and the distinguished circle of Englishmen that frequented More's home, steadily undermined medieval philosophy and scholasticism. The religious orders beheld his work with horror. They accused him of treachery, sought to imprison him in a monastery, but the bland Erasmus laughingly evaded them. He pointed the way but lacked the courage to follow the road that led where Truth beckoned; perhaps his wisdom, thoroughly grounded in the frailties of mankind, dissuaded him from action. He was the scholar and not the man of action. He did not believe that changing institutions would alter the inherent characteristics of man. He loved Mother Church and wished her to don garments as pure as they were in the days of her tribulation. He thought her aims a little too earthy and wished to purge her of her errors but did not wish to destroy her. He was in a most uncomfortable situation. Luther accused him of conservatism, the monks of being a pernicious radical. It was time for him to die. He had done his work and, like the spent servant, was no longer required. History will not forget Erasmus. He taught his generation to think. He introduced the scientific method of reasoning into biblical study and was thus a forerunner of the clear vision that actuates the scientist of today. He had substituted critical investigation for blind faith and was one of the apostles of Modernity. Freedom of thought was his creed. In a letter to Cardinal Campegio he writes, "If we want truth, every man ought to be free to say what he thinks without fear." He did not know that his friend Sir Thomas More was to die because of the very Reformation that he had helped to create; the gentle More, one of the excellent products of the system that Luther condemned.

Sir Thomas More was the swan-song of the Church in England. He revered his time-hallowed creed and led a life that honored the faith he held. He was a man of sincerity and truth, conscious of his desires and the limitations of mortality. Had he yielded to his wife's practical advice and the suggestions of the daughter he loved, the wise Margaret, he would have avoided the headman's axe and the Church would have been denied a saint, but filled with the steadfast piety that renovates ancient creeds, he smilingly faced death. Luther did not know Sir Thomas More, he had not read his letter to Margaret that he wrote to her with a coal, while he was in prison. "Pecks of cole," he said, "would not suffice to express all his love for her." With that deep sense of humor that his portrait by Holbein shows, he urged his executioner to be brave. It is not recorded how he looked when his wife scolded him for adhering to a faith that was anathema. "I marvel," she said, "that you who hitherto have been taken for a wise man will now so play the fool as to be here now in this close, filthy prison, and be content thus to be shut up, among mice and rats, when you might be abroad at your liberty if you would do as all the Bishops and best learned of this realm have done." She was more verbose than Job's wife but the latter's, "Dost thou still retain thine integrity? Curse God, and die," still rings down the ages.

### SERVETUS AND HIS CONTEMPORARIES

Into this web of devious strands spun by mortals, Servetus was cast. A spell had been woven by his age and Servetus, thinking he was a captain of his fate, was

only the agent of strong impulses circulating throughout Europe, subject, as are all men, to prevailing tendencies. When fourteen, he entered the University of Saragossa where a very liberal and talented teacher, Peter, Martyr de Angleria, influenced him. At Saragossa, Servetus learned the classics and acquired a smattering of Aristotle and scholastic philosophy, mathematics, geography and astronomy. He then went to Toulouse where he studied law. Despite his failure to become a priest, the chief interest of Servetus was religion and at this university he became acquainted with the Scriptures. He soon became a critic, influenced by the Reformers, and felt himself at full liberty to give his own interpretation of what not only the Church but its doctrine, required. He showed the enthusiasm and self-confidence of the genius; the characteristics that have led many a gifted son to a premature grave. Man can recognize deviation. He is not skilled at differentiating eccentricity from the sublime and therefore condemns the irreconcilables impartially. Servetus overlooked the overwhelming fact that the Church had been laboriously created and maintained for fifteen hundred years; with pitiful confidence he sought to alter an institution that was ingrained in the minds and hearts of men, that was universal. He lacked the caution of Erasmus. The world would marvel at his "De Trinitatis" (the world which had stoned the prophets). The names of Luther, Calvin, Melanchthon appeared on the title pages of their books; his, Michael Servetus, would appear also. Was he not superior to the others in culture?

The "De Trinitatis" is a small book, yet one regards it with a feeling of awe. A man died so that this book might proclaim a message strangely modern, despite the Latin script in which Hebrew and Greek words flash barbarically. In a strange matter of fact tone, weighted with authority, Servetus attacks the very foundations of the Church he loves; again presenting as incongruous a spectacle as Jeanne d'Arc before the seat of the Inquisition; Jeanne who maintained to the end that God spoke to her through the intermediary of the Saints and not that of the Church. On the first page of the book, the name of Michalem Servito figures prominently, even his alias, Reves, as though he would naively absorb all the glory that the tract would draw. The publisher's name is not seen. He was wise in his generation.

Bucer was so incensed at Servetus that he savagely demanded his disembowelment. Bucer was usually of a mild disposition but Servetus had the undesirable quality of antagonizing men. He attacked the established order, reviled the reformers and yet so guileless was his mind, that he often wondered deeply as to the cause of his enemies' antagonism. His lack of awareness of the situation may have been due to a nature that could not harbor vindictiveness and therefore failed to see it in others. Luther called the "De Trinitatis" "ein greulich bös Buch." He resented the attack on the Doctrine of Justification by faith. Daunted by the indifference of the German and Swiss Reformers, Servetus left Switzerland for Paris in 1532. He failed to understand why his brother reformers had spurned his overtures. He did not perceive that enthusiasm runs in a narrow groove and that in the eyes of Bucer he was as reprehensible as Judas, for did he not spurn the chief tenets of the new creed. He found that rebels punished rebellion and that the man without a party is an isolated being. Fearing Roman Catholic France, he assumed the alias of Villaneuve, from his native town Villaneuva. He lived for twelve years in Vienne, the town that has recently constructed a monument in his memory, a figure signifying Remorse. Under his false name he wrote and edited many works at Lyons. His employers entrusted important work to him, one of which was the Geography of Ptolemy. Here the overwhelming desire to air his vanity again marked Servetus and he

carefully informs his readers of the labor he has undergone on their behalf. "For days and nights have I labored at my task," he writes. He makes a pithy comment in this book on scrofula. "I have myself seen the king touching many afflicted with this disease but I did not see that they were cured." He was a keen observer and yet blinded by mysticism, an excellent physiologist, still an astrologist; a lover of truth although a hunted man, concealing his identity under a false name. How could one man be all these things? The only answer is that of Walt Whitman's; when accused of being inconsistent, the latter said defiantly,

> Do I contradict myself?
> Very well then I contradict myself.
> I am large, I contain multitudes.

Genius resembles a precious stone and like the jewel contains many facets. The children of genius contain multitudes, the world. Like Jeanne d'Arc they can tend sheep, lead the French army to victory, hear Saint Michael and proclaim the rights of the individual. Judged by ordinary standards the genius is abnormal; regarded by appropriate methods he is inspired and unique. What but genius could have made Servetus proclaim in the darkness of the sixteenth century that all men have a right to express their opinions without fear of consequences; a statement which appears trite in the twentieth century with its Hyde Parks, but an alarming announcement in Servetus' time. Was not Huss burnt and did not More die because of intolerance?

At Lyons, Servetus met Dr. Champier who persuaded the idealist to study medicine, which was a lucrative means of gaining a livelihood. Medicine was held in ill repute by the sixteenth century and was mostly practiced by Jews and Moors. Servetus entered the college of Calvi and then that of the Lombards to study medicine. He was a fortunate pupil of Joannes Guinterus, Jacobus Sylvius, Joannes Fernelius and was associated with Andreas Vesalius. He was one of Joannes Guinterus' two prosectors and prepared the subject for each day's demonstration. Vesalius, repudiating the authority of Galen, became the creator of modern anatomy. He found a kindred spirit in Servetus who revelled in demolishing icons. Fortunate indeed was the founder of practical physiology, the exponent of the pulmonary circulation, in his scientific associates. Without minimizing his ability at all, one cannot but reflect on the whims of Fortune that led a zealous theologian to travelling the bleak highroad of science. Sarah Bernhardt was once asked to what she attributed her fame; "Luck," she replied bluntly. One cannot evade the fact that it was luck that enabled Servetus to embrace physiology, after a chequered career, and that made him famous because of his discovery of a fact that he himself used only to support his theological views. Servetus did not realize the true import of his discovery and even if he had, he would have regarded it as trivial, as a manifestation of that divine force in which he was immersed and strove to describe. Physiology was just a milestone on the long road that Servetus traversed, towards a goal that promised spiritual exaltation and truth, a goal whose light was so intense that it blinded him to other facts of existence. Had he been told that Harvey was to appear, Withering to discuss digitalis, Pasteur to expatiate upon rabies, he would have listened absentmindedly and at the first pause in the conversation would have ardently discussed the meaning of the Hebrew word Adonai. He was a child of his period.

It is absurd to describe an age as religious in the sense that all men participate in the feeling of spiritual controversy that beset the leaders of the sixteenth century. Historians may at times take this false, biased view as though they were medical students who require a classification of disease without deviations. We know that tuberculosis attacks lungs, lymph glands, intestines, bone and kidneys; that many organs in the body suffer from its ravages, that its onset

may be acute or insidious, that it may simulate other diseases; result in arrest or death. How shall we define disease, a manifestation of life, a warring of elements, often the response of the body to an aggressive irritant. We devise classifications, knowing full well that they are temporary, incomplete; that with increasing knowledge a rearrangement is obligatory and that even when in full possession of facts, the judgment of the writer, at best an intangible and personal attribute, influences the scheme, making for fluidity rather than crystallization. We can only hope to give an approximate view of the situation. Thought, another manifestation of life, resulting in institutions, produces the same problem of attack to the historian, that disease gives to the pathologist. He can only suggest that certain tendencies existed; not that the heart of man has changed perceptibly, but that new difficulties, like so many permutations and combinations, have produced different results. Men in the sixteenth century strove for wealth, wrote poems, made war, loved, sickened and died. Only the few were interested in scholasticism. Many were content to plow the field, garner the grain, herd sheep, sail ships and pursue the daily round. They were too busy to indulge in disputation. The leaders of thought were the theologians. They poured the mighty rivers of their intellect into the narrow, immovable bed of religious controversy. They colored the era and their conspicuousness attracts the historian.

Joseph Guinterus in the preface of his "Anatomical Institutions" informs us that Michael Villanovanus, a distinguished littérateur and authority on Galen, assisted him ably. From his association with Guinterus, Servetus acquired the anatomical knowledge that enabled him to elucidate the mechanism of the pulmonary circulation. The book in which this important contribution to science was written was seen by only a few theologians and remained unknown to the world at large for a century and a half after Servetus' death. Like most scholars, he was hounded by poverty and forced to become a teacher in order to gain a livelihood. He lectured on the geography of Ptolemy and the science of astrology; the latter science was a peculiar hybrid, composed of the nucleus of astronomy and the false belief of the influence that the stars exert on man.

The medical world in the early sixteenth century contained two hostile factors, the Galenists who swore allegiance to the Greeks, and the Averrhoists who docilely followed the precepts of the Arabians. Servetus, the friend of Champier, naturally admired the teachings of Hippocrates, to which his scholarly attainments added further zeal. Nevertheless, the independence of view which strongly characterized the man was manifested in the impartiality with which he accepts logical Arabian views.

After a quiet haven, which was brief indeed, Servetus again plunged into difficulties. A new enemy had arisen; not the healers of the soul this time, but of the body. The Medical Faculty of Paris, a body of men who were to be made immortal by the ridicule of Molière, now arose in arms against Servetus. They resented his false views of astronomy and their opposition was made more vehement because of his success. He was a fluent teacher and his lectures on geography and astrology had attracted a multitude. His vogue as a general practitioner was excellent, not that he did good work (his brother practitioners were fully aware of his deficiencies) but he gave the public what it wanted. He could cast a horoscope with the skill of the witch of Endor. The public at the time believed in witchcraft and would desert a bearfight, one of the most amusing of pastimes, to flock in to hear one Will Shakespeare and his three witches discuss the fate of Macbeth. He had become conspicuous; Michael Villaneuve of Paris was as prominent as Michael Servetus of Switzerland. He was summoned before the Medical Council, and was mildly told that he must be more respectful in the

future. They were very lenient and suggested that he was transgressing the boundaries of true science by dabbling in astrology, a disreputable sister of witchery. The Dean of the Council rebuked him several times personally. He was warned of the difficulties confronting him if he did not mend his ways. The stars were to remain in their spheres; their music to be heard by celestial ears and not transferred to mankind. They were not to play the unnatural role of consultants to doctors. One must not cast nativities or prescribe remedies according as to whether Venus or Jupiter was in the ascendancy. Here they attacked the very stronghold of Servetus' success. He was really sincere and truly felt that the planets influenced the physical condition of the ill. He resented their advice and became defiant, felt that he was misunderstood, disdained tolerant suggestion and indignantly proclaimed that his medical brethren would suffer for their opposition.

His threats left the medical profession undisturbed. They publicly accused him of being not only a fraud, but a talkative one. He resented this intensely and immediately began to write a pamphlet in which he scourged the tender parts of his opponents. When the doctors ascertained that this book was in the hands of the printers, panic overtook them. They could see with a prophetic eye a Molière in the offing, and did not care to see him preceded by a physician. One can withstand war by an unfriendly power, but internecine strife is disastrous. The Faculty of Physicians petitioned the Parliament of Paris to suppress the publication of this tract. They also insisted that the apostle of Divination, as they termed astrology, be forbidden to lecture on the stars in their courses. He was therefore summoned to appear in Parliament and explain his attitude. In the meantime the wily Servetus had had his pamphlet printed and distributed before the day he was to appear in court. The doctors found to their chagrin that numerous members of the profession and laity had already received the tract and that Servetus had partially won the day. They resorted to other manoeuvers. If one could not trap the fox one could put strychnine in his food. They suddenly became religious and wailed that he was a heretic; "He is practicing," they cried, "judicial astrology." He was therefore summoned before the Inquisition as an enemy of the Church and rebel of its decrees.

The Inquisition, a form of third degree, that partook of the diabolical cunning of scholasticism and the savagery of the redman, held freedom of thought, both scientific and religious, in subjugation. One could think but not speak. There arose men who felt that life without honor was a worthless thing; they talked and their views spread. To crush this infamy the Inquisition was elaborated. If one heretic was caught, they tried to ascertain from him the names of his friends; if he told he would be burnt at the stake without the preliminary tearing apart of his limbs. If he kept silent, they had many ingenious devices to extract the truth or that which they considered the truth; the confirmation of their suspicions. The Inquisitors forgot their role, that of spreading the gospel of peace on earth and good will to men. It is true that they handed their victims over to the secular arm for torture, but in order to hear the words of guilt from the accused, they were forced, despite their better inclinations, to go into the torture chamber where they could more easily hear the confessions of agonized men. Familiarity blunted their finer senses and, without becoming aware of it, they became cruel. The butcher who slaughters lambs grows hardened to his task and blood to him becomes a red liquid. The inquisitioners became inspired and they evolved ingenious devices. They would proceed as follows: a rag would be put in a man's mouth; the pharyngeal end was moistened with water which produced an attempt at swallowing. Temporary strangling was the result and when the rag was removed it was

covered with blood. The act was then repeated; the poor unfortunate wretch would then plead guilty even to the murder of his own mother. Many other means of torture were in use but they all proved unavailing. Truth, as is her way will triumph. The Latimers and Cranmers were numerous and to them death was a more welcome thing than life without honor. France at this period had an established Inquisition although Papal inquisitors, usually Italians, with the sanction of the Holy See and the French sovereign, presided in the large urban centers. The civil tribunals of the realm were given the power to judge their decisions. The Inquisition found him innocent and his discomfited fellow-practitioners had to await the judgment of Parliament. He was condemned by this august body to cease the practice of divination, to destroy the pamphlets circulated and those in his possession, and to honor the members of the medical faculty. Servetus grew despondent. He had again met defeat; a man whose moods were volatile, now elated, then depressed, felt that he could no longer endure public ostracism and professional disdain. His main source of income was taken from him when he was forbidden to cast horoscopes. He therefore left for Charlieu. His genius for trouble again made him leave; so he departed for Vienne, where he lived in the precincts of the palace and under the patronage of the Archbishop, Pierre Paumier.

### SERVETUS AND CALVIN

John Frelon engaged Servetus as editor. Frelon was a friend of Calvin and was a very learned and tolerant man. He did not know that Villeneuve was the dreaded Servetus. At this period Servetus entered into correspondence with Calvin. Frelon was the intermediary. Calvin in a letter to Frelon stresses Servetus' lack of humility. It seemed that God alone could convert the pugnacious scholar. Calvin despaired of mortal means. "He is a Satan," he cried, "who keeps me from my work." Servetus knew that Calvin was the head of the Church of Geneva, but that knowledge left him unperturbed. He resented advice. He had written to him on transcendental dogma as though he were an equal; had aired doubts which Calvin had possibly suffered from and was trying to suppress. The latter knew that his opponent was learned, detested his subtle heretical arguments from which he would not budge, disliked his familiarity. Calvin was a great man, possibly he could not have been the great Reformer had he possessed a sense of humor, but he did not see how absurd his condemnation of Servetus' arguments were when he himself was a hunted man, a leader in the Reformation. The letters between both degenerated into abuse. It is claimed by zealous adherents of Servetus that Calvin plotted his death because of the former's insultant attitude. It was not Servetus' views they claimed, but his confidence in expressing them, his skill in conveying them, that antagonized and made a deadly enemy of Calvin. The latter also resented the failure of his efforts. Servetus was a Reformer, had asked for spiritual advice, had received the best available at the time, Calvin's, and yet had repudiated his suggestions. Calvin sent Servetus his great achievement, the "Institutions of the Christian Religion." The latter calmly refuted the chief tenets of Calvin's creed, blithely dissecting the laborious propositions and reducing them to absurdity, thus rending to pieces the very flesh of Calvin. The shafts he hurled into Calvin's vulnerable side were not enough. He proceeded to turn their barbed ends. He culled phrases from Scripture to minimize his opponent's views. The situation was unendurable. The suppliant had turned critic and the subject reviled the head of his realm. To the destructiveness of his logic Servetus added the luster of Holy Writ and Calvin gazed with horror on the returned copy of his "Institutions" freely annotated on the margins with Servetus' candid views. The opponent of the Pope turned to destroy the unhappy man who

like Lucifer defied God from Chaos. To a friend Calvin cried, "There is hardly a page that is not defiled with his vomit."

Calvin in deadly earnest now sought to encompass Servetus' death. Slow fire he objected to, but the sword would do. Anything, anything to rid the world of this monster, this vile heretic! A letter is still existent which compromises Calvin; through which posterity regards askant an otherwise great man, one who was really touched with the divine afflatus. Like David, who praised and worshipped God but forgot him when Bath-sheba strolled across her courtyard, Calvin sank to a sordid level in his encounter with Servetus. He had lost his sense of proportion and wrote to Farel saying, "Servetus offers to come hither if I approve; but I will not pledge my faith to him; for did he come, if I have any authority here, I should never suffer him to go away alive." There are mitigating influences in this quarrel. It would take a calm man to see his life work withered by the phrase which Servetus hurls at Calvin, "Thou unworthy and blasphemous individual who desecrates the works of God." Granted that Calvin was responsible for Servetus' death, it must be considered that the gentle Sir Thomas More, than whom no kinder man and merciful ever lived, approved of the death of heretics. Even Jeanne d'Arc, who had striven to save the English wounded at one time in her career, contemplated a crusade against the Infidel. Had not the Bible said that brother would kill brother and father his son, to perpetuate the true faith? They earnestly believed the words written ages ago. They did not know that conditions alter the very meaning of words which come down the centuries; that a word is merely a symbol of existing circumstances, which when they depart, leave the word a mere husk of its former being.

Calvin was the instrument of the change that his generation demanded. He made a hidden urge articulate and his combat with Servetus was one destined by the age. The naive Servetus thought that man could be compelled by reason; felt that to pronounce the truth was enough and that all would hail his vision, but he too had to follow his Master to an early grave. Voltaire stresses the narrow bond that allies a man's weakness to his virtues. Calvin's flinty heart made him not only a bitter, unmerciful adversary but a man apathetic of this world's goods. He left a negligible amount of money after his death. It is true that Calvin's deliberate plotting to destroy Servetus is an abhorrent affair, but personal motives may be ignored. He was a product of an intensely religious period, not a tolerant age that pitied the Magdalene, not an age that would ask that he who was free of sin should cast the first stone, but an age that was imbued with self-righteousness and like the Pharisees felt that it must defend God, the Immortal, who had existed when man was as yet represented by a unicellular organism. It is unjust to regard Calvin the man rather than Calvin the symbol, the representative of a theological era. The age regarded heresy as a very grave error, not only from the religious, but the social viewpoint. Had not Servetus compared the Trinity to Cerberus, the three-headed guardian of Hades? Calvin may have been introspective, he may have realized that he was shattering a mighty faith but he did not want the destructive process to go too far. He regarded himself as a defender of God and his true faith as he conceived it. Protestantism was in a perilous state, fighting for its very existence in a rapacious world that would devour it. One could contend with Catholicism but civil war was fatal. The situation was similar to that of the Jews who had fled from Spain to seek refuge in Holland and peace to worship their God. Uriah and Spinoza were excommunicated not so much for their dissentient views, as that the Jews to protect the many sacrificed the few. They feared to antagonize the religious beliefs of the Christians, who tolerating peaceful Jews, would rise against them if they heard that they harbored dissenters.

One of the most intent students of Servetus, Henri Tollin, says of him that the moment of greatest intensity and joy in Servetus' life was when he discovered the beauty of the Bible. Ravished by its councils, he renounced the idle pleasures of this world, its sham honors, and fictitious glory, for the peace that lay within the Book of God. "Il n'a qu'une seule passion, Jésus." To gain access to Jesus and reveal him again to a world that had surrounded his unadorned phrases with a complicated tradition that sometimes obscured the Christ, was the object of his life. Any view that conflicted with his conception of the Son of God, he resented wholeheartedly and opposed with the vigor of a Spanish warrior. This is the crux of the situation. Around this orbit Servetus and Calvin revolved and clashed. Calvin in his own sincere, puritanical way believed that Servetus was the Devil himself, uttering wicked lies under the guise of erudition. Servetus, admiring Calvin's astuteness, nevertheless felt that he was not doing justice to the finer conception of Christ. The situation was intolerable to both. Eight years after Servetus' death, Calvin wrote a letter to the Marquis of Poët in which he definitely states his opinion of him, untinged by mercy, the cooling quality of the years of retrospection.

Honor, glory and riches will be the reward of your labor, provided that you do not make the mistake of permitting these zealous fanatics to remain in the country, who are arousing the inhabitants to unite against us. Monsters of that type should be suppressed, as I succeeded in doing with Michael Servet, the Spaniard.

Servetus would not admit that the Eternal Son of God was to appear as man but only that a man was to come who should be the Son of God. He was impressed with what we call the historical view of theology.

Oecolampadius writing to Bucer says:

I saw this week our friends of Berne who make their compliments to you and to Capito. They are very much offended with the book entitled 'De Trinitatis Erroribus,' which some of them have seen. I desire that you would acquaint Luther that this book was printed out of this country and without our knowledge. Our Church will be very ill-spoken of unless our divines make it their business to cry him down. He wrests all the passages of the Scriptures to prove that the Son is not co-eternal with the Father, and that the man Christ is the Son of God.

We can thus readily see that the motives that actuated Calvin were not personal but dictated by necessity. To enable Protestantism to live, Servetus had to die. Calvin felt that enough was done when the roof of the Church was removed. Behold, this rogue wanted to tear down the walls!

To further illustrate the critical tendencies of Servetus' mind one need only quote the preface to the translation of the Bible by Pagninus. Servetus the editor says:

We are taught by that wise man Jesus, the son of Sirach, that the Hebrew tongue when translated into any other language becomes defective, and loses much of its meaning. It is obvious that the energetic spirit, emphatic expression, harmony, antithesis, allusions and the like are impaired by our translations. Therefore both ancient and modern interpreters, despite great care, have never fully realized the true import of the Scriptures; especially those, who being ignorant of the affairs and customs of the Hebrews, fall into error where the literal and historical sense is concerned; from which alone one can meditate on future events. I suggest again and again, Christian reader, to first learn Hebrew and then study diligently the Jewish history before you enter upon the study of the prophets.

The Song of Solomon has at times been interpreted as magnificent poetry, at others as a revelation. Servetus warned against this latter tendency; the Jews, he felt, were like other races; their prophets were men of the times, who despairing of prevailing tendencies, warned the recalcitrant race. "Do not seek," he urged, "divine revelations in phrases, which if

regarded in the light of contemporary events, become commonplace."

Servetus lives, not because he discovered the pulmonary circulation; he himself attributed little importance to that which our day regards as a splendid achievement. The age had commanded the discovery of this fact. There are other scientists who contest with Servetus for the honor of this achievement. He looked upon it as the idle product of an uneventful period in his life and informs us of this revolutionary event as a casual support for an abstruse theological view. The world at large is not interested in Servetus the doctor, but Servetus the man of vision and steadfastness, who would die for his views. Science and brilliant men, as inevitably as the day follows the night, could now proclaim facts that would adorn a new era. The Renaissance had given them birth.

Servetus sent a copy of his "Christianismi Restitutio" to Calvin. He tried repeatedly to recover it but failed. He had, however, another copy in his possession. The world at large remained ignorant of the existence of this book until Wotton in his "Reflections on Learning" revealed its presence. In the fifth book of the "Christianismi" Servetus, to illustrate a metaphysical assumption, utilizes the physiological fact that has helped make him famous. He informs us that the right heart sends blood through the pulmonary artery to the lungs, whence the pulmonary veins transmit the fluid, now become crimson, to the left ventricle. Harvey was to amplify this statement.

Calvin informed Cardinal Tournon, Archbishop of Lyons, that Servetus was a heretic and was masquerading under the false name of Villeneuve. He was cast into the Vienne prison from which he escaped to Geneva; was recognized there and arrested at Calvin's command. The conditions in prison at that time were execrable. Servetus, now in his first stage of martyrdom, was covered with vermin and filth. He contracted an intolerable diarrhea and in despair wrote to the Council. Nothing, he claimed, had been done for him in the way of cleanliness and his plight was pitiful. He suffered from the cold, colic and vermin. . . . "For the love of God, Sirs, in pity or in duty, help me!" Even in the depths, reduced to desperate extremes, he could not forget his self-assurance and in his plea the word duty rings like a golden bell. The Council replied by pronouncing the death sentence. He requested an interview with Calvin which was granted. The latter and two of the Councillors entered the prison an hour before noon on that fateful day, October the twenty-seventh, 1553. Calvin's face bore the fixity of features carved in granite. The stammering, awkward cries for mercy that Servetus uttered left him unperturbed. The phrase, "The quality of mercy is not strained," did not exist in his vocabulary. "Servetus," he said, commenting upon the situation afterwards with a friend, "looked as stupid as a beast." The interview was over, but it was far from complete, posterity would finish it for both Calvin and Servetus. All hope gone, his manliness crept back to Servetus until it filled his very being and in the proud composure of the man that he was, he headed the procession to the stake.

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[For remainder of References see p. 136.]

# BOOK REVIEWS

HISTORY OF SCOTTISH MEDICINE. By John D. Comrie, M.A., B.SC., M.D., F.R.C.P. 2 Vols. Ed. 2, Published for The Wellcome Historical Medical Museum by Bailliere, Tindall & Cox, London, 1932.

This "History of Scottish Medicine" in two volumes, profusely illustrated and delightfully presented, was made possible by the enthusiasm and generosity of Sir Henry S. Wellcome to whom the profession is indebted for the Wellcome Historical Museum in London. Of course, every physician and surgeon is familiar with the outstanding names such as Abercrombie, Thomas Young, Robert Whytt, the Monros, Charles Bell and others. These volumes unfold a great many important milestones in medical progress that originated in the Scottish schools. Men, events, institutions and conditions are spoken of in a manner that will not only interest and entertain but also instruct medical practitioners and students along lines that hitherto have been sadly neglected.

The contributions of the Scottish schools to the advances of medicine at last are presented in a permanent manner that will create renewed interest and research in the history of medicine in various countries. Works like Packard's "History of Medicine in the United States" and Comrie's "History of Scottish Medicine" are distinct contributions to our medical historical literature which will take their place as classic works of reference. An innovation in books of this kind has been adopted in this instance by the interesting side-heads throughout the book which make easy reference for readers who can easily refer to specific paragraphs. It is unfortunate that a wider margin was not allowed as these otherwise almost perfect volumes create an impression of skimpiness by having the side-heads run almost to the edge.

It is a distinct tribute to the author that he has succeeded in going into minute details without being boring. The use of small type has enabled the insertion of original quotations without interfering with consecutive reading by those who wish to skip certain matters.

Congratulations are due to Dr. Comrie, to Sir Henry Wellcome and to the publishers for this book.

THE LABORATORY IN SURGICAL PRACTICE. By E. C. Dodds, M.V.O., M.D., and Lionel E. H. Whitby, C.V.O., M.D. (Camb.), M.R.C.P. (Lond.), D.P.H. Vol. 1 of series on Modern Surgical Monographs, Ed. by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. London, Constable & Company, Ltd., 1932.

This book in twelve chapters gives the various laboratory methods on which surgeons are today dependent for accurate diagnoses. Carefully arranged and well written, the book gives a concise insight on the subjects covered for the busy surgeon. Thoroughly practical and giving the elemental facts, the book is intended for the surgeon himself rather than for the laboratory worker. It will be found invaluable as a work of reference.

PHYSICIANS OF THE MAYO CLINIC AND MAYO FOUNDATION. Vol. II, Phila., W. B. Saunders Co., 1931.

This volume supplements the volume published in 1927 and brings up to the time of publication the biographies of men associated with the Mayo Clinic. It is an unusually important work of reference for those who have an appreciation of modern surgery and its history. The bibliography accompanying each author is of unusual interest. The inclusion of a large number of portraits lends a personal interest to the volume that is generally lacking in a work of this kind.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. By Fritz Konig, Geh.-Rat Prof. Dr. Med. Wurzburg, and Georg Magnus, Prof. Med. Bochum. First Three Parts. Stuttgart, Ferdinand Enke, 1932.

The first three parts of this splendid textbook fulfill the promise made in the preface that the work would be a complete reference and textbook of the most authoritative kind. The illustrations, some of which are colored, leave nothing to be desired and the text lives up to expectations. A more complete discussion must be left until the work is complete. It is now appearing in parts of about 150 pages each and will be complete in four volumes.

Die Spezielle Chirurgie der Gehirnkrankheiten. Redigiert von Prof. Fedor Krause, 3 Bande. II. Band, Die epileptischen Erkrankungen, ihre anatomischen und physiologischen Unterlagen sowie ihre chirurgische Behandlung. By Prof. Fedor Krause and Dr. Heinrich Schum, Berlin, 2. Halfte, Neue Deutsche Chirurgie, Begrundet von P. von Bruns. Herausgegeben von H. Kuttner in Breslau, 49 b. Band, Stuttgart, Ferdinand Enke, 1932.

This interesting book is the second volume on surgery of the brain covering epileptic diseases and their surgical treatment written by Drs. Krause and Schum. It would be a work of supererogation to attempt to criticize this work which is destined to become a classic. Concisely yet completely, it covers the subject with a thoroughness that we have become used to in this remarkably well-edited Series. In 400 pages, the authors have succeeded in including the surgical procedures connected with this condition. Illustrations are profuse and the bibliography is almost appalling in its completeness. The neurological surgeon will find this book indispensable.

Dynamic Retinoscopy. By Margaret Dobson, M.D., London, Humphrey Milford, Oxford Univ. Press, 1931.

This little monograph on "Dynamic Retinoscopy" in nine chapters covers the subject completely. It will be of value to those interested in the subject.

Die Uberlieferung der Hippokratischen Schrift. By Hans Diller. Philologus Zeitschrift fur das klassische Altertum, Begrundet von F. W. Schneidewin und E. Von Leutsch, Herausgegeben von Albert Rehn and Johannes Stroux, in Munchen, Supplementband XXIII, Dieterich'sche, Leipzig, 1932.

This discussion of Hippocratic writings is done with the ideal German thoroughness. It is invaluable to the student of the classics and to the student of historical medicine. To be properly considered, this work would require a longer review than is feasible in the Journal. Suffice it to say that any student will do well to have this work at hand for continual reference in any consideration of the all important Hippocratic writings.

Ikonographia Urologica. Im Auftrage der Deutschen Gesellschaft fur Urologie, Herausgegeben von Alfred Rothschild, Berlin, Victor Blum, Wien, and Friedrich Necker, Wien, IV. Lieferung. Berlin, Georg Stilke, 1932.

This is the fourth part of a serial publication by the German Urological Society on "Ikonographia Urologica." The pictures, as was to be expected, are perfectly splendid. Special credit must be given to the colored reproductions, in spite of which the price is extremely low. The four parts published to date, comprise 109 illustrations. The entire work, on completion, will be made into an atlas. There is probably no field in medicine that is more dependent on fine illustrations for the proper teaching of the subject than is urology. The German Society's publishers are to be congratulated upon the successful accomplishment of a very difficult task.

Lehrbuch der Röntgendiagnostik (Text-book of Roentgen Diagnosis). By H. R. Schinz, W. Baensch and E. Friedl, with the collaboration of M. Holzmann, A. Hotz, O. Jüngling, E. Liebmann, E. Looser, and K. Ulrich. Ed. 3, revised. 2 vols., Leipzig, Georg Thieme, 1932.

Before us we see the high-water mark in the ever-growing stream of radiological literature. This is truly a magnificent publication, complete in every detail of radiological diagnosis, profusely illuminated with nearly three thousand roentgenograms or drawings. The text leaves nothing to be desired, unless perhaps a little more mention of the important contributions from American sources, both in the text and in the bibliography, but this predominance of references to European literature is quite understandable. One seeks in vain for serious omissions in this beautiful work; but the commendable phases are so numerous and outstanding that criticisms fall flat. The publisher has done his work well, the text and the illustrations leaving nothing to be desired.

Volume I devotes only thirty pages to an introductory chapter on roentgen physics, a

commendably brief but valuable prefatory section. Many text books on *x*-ray diagnosis consume a large percentage of their pages in useless discussions and descriptions of obsolete apparatus and methods, and illustrations of instruments freely and fully described in manufacturers' catalogs.

Following this brief section on physics and instruments, the authors proceed to the most elaborate and authoritative roentgen diagnostic text in existence in any language, considering in order the skeleton (bones, joints, and soft tissues), the study of which fills the remainder of the 700 pages in the first volume.

The second volume concerns the thoracic organs, the digestive tract, the liver, pancreas, and the spleen, the urinary tract, and a final chapter on gynecology and obstetrics. An excellent index, most satisfactory in detail, terminates this monumental work.

Technique de L'Ostéosynthese. By Robert Danis. Paris, Masson et Cie, 1932.

This monograph on the general treatment of fractures details the procedures which are employed in Dr. Danis's clinic. Among other things is shown a fracture table which apparently is very efficient in his hands.

The technique involves the use of wire as suture material both intracortically and transcortically, and he describes instruments for the placement, tightening and fixation of these sutures. He also describes an electric saw for bone graft work, tibial grafts being employed. The *x*-rays would indicate a high degree of success by his methods.

In the author's use of wire, he describes an ingenious method for obtaining traction in the line of hyperextension for destructive processes in the vertebral bodies either from fracture or disease, by inserting the wire through the spinous processes, after sufficient hyperextension of the spine has been accomplished.

Text-book of Massage and Remedial Gymnastics. By L. L. Despard. With two chapters contributed by Hester S. Angove. Ed. 3, Humphrey Milford, Oxford University Press, 1932.

A new edition of Despard's "Text-book of Massage and Remedial Gymnastics" is always welcome. In this instance, the work has been brought thoroughly up-to-date. In the opinion of the reviewer, this book maintains its previous standard as "the best book on massage in the English language."

Emergency Surgery. By John William Sluss, A.M., M.D., F.A.C.S. and John Walter Martin, M.D., F.A.C.S. Assisted by David Hart Sluss, M.D., F.A.C.S. and Camilius Bowen DeMotte, B.S., M.D., Ed. 5, Phila., P. Blakiston's Son & Co., 1932.

The fifth edition of Sluss' "Emergency Surgery" has grown to almost nine hundred pages and remains, as always, a thoroughly practical and up-to-date manual on a subject which is daily growing in importance. The authors have certainly succeeded in assembling in compact space the essentials of a very intricate subject.

Manual of Surgery. By Alexander Miles, M.D., LL.D., F.R.C.S. Ed. and D. P. D. Wilkie, M.D., F.R.C.S. Ed. and Eng., Volume II (Extremities—Head—Neck), Volume III (Thorax—Abdomen). Ed. 8, Oxford Univ. Press, 1931.

These two volumes complete the work the first part of which was reviewed in a recent issue. These volumes give the modern British viewpoint on the subject and are fairly up-to-date. While the illustrations leave much to be desired, it must be remembered that the work is published at a very low price.

A Textbook of Psychiatry. For Students and Practitioners. By D. K. Henderson, M.D. (Edin.), F.R.C.P.S. (Glas.) and R. D. Gillespie, M.D. (Glas.), M.R.C.P., D.P.M. (Lond.) Ed. 3, Humphrey Milford, Oxford University Press, 1932.

This is the third edition since 1927, a fact which bespeaks the success of the volume. This work is dedicated to Dr. Adolf Meyer, of Johns Hopkins, and both of the authors have had training both here and in England. As a modern conservative view of psychiatry, this book may be highly recommended.

DIABETES, ITS TREATMENT BY INSULIN AND DIET, A HANDBOOK FOR THE PATIENT. By Orlando H. Petty, M.D., F.A.C.P. With an introductory Foreword by John B. Deaver, M.D. Phila., F. A. Davis Co., 1931, Ed. 5, 231 pp.

Five editions since 1924 would indicate that this book has made a definite place for itself. It is a thorough, practical guide and perfectly safe to put in the hands of patients.

## BOOKS RECEIVED

All books received by THE AMERICAN JOURNAL OF SURGERY are listed in this column as soon as possible after their receipt and this must be considered as adequate acknowledgement. Books that the Editor considers of special interest to our readers will be reviewed in a later issue.

BIOLOGICAL TRAGEDY OF WOMAN. Translated by Stephenie Ofental. N. Y., Covici, Friede, Inc., 1932.

CLINICAL STUDY OF THE ABDOMINAL CAVITY AND PERITONEUM. By E. M. Livingston. N. Y., Paul B. Hoeber, Inc., 1932.

DIATETIK BEI CHIRURGISCHEN ERKRANKUNGEN. By F. S. Lapp and H. Neuffer. Berlin, Julius Springer, 1932.

DISEASES OF THE CORONARY ARTERIES (MYOCARDITIS). By Don C. Sutton and Harold Lueth. St. Louis, C. V. Mosby Co., 1932.

DOCTOR EXPLAINS (THE). By Ralph H. Major. N. Y., Alfred A. Knopf, 1931.

HEFTE ZUR UNFALLHEILKUNDE. II. DER HEUTIGE STAND DER KNOCHENBRUCHBEHANDLUNG. By Moritz Borchardt. Berlin, F. C. W. Vogel, 1932.

KONSTITUTION UND VERERBUNG IN DER ORTHOPADIE. By B. Valentin. Stuttgart, Ferdinand Enke, 1932.

LEITFADEN DER KOSMETIK. By A. Buschke, Alfred Joseph and Werner Birkenfeld. Berlin, Walter de Gruyter & Co., 1932.

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PRACTITIONER'S LIBRARY OF MEDICINE & SURGERY. 2 vols. N. Y., D. Appleton & Co., 1932.

PUBLIC HEALTH IN N. Y. STATE. Albany, N. Y., State of N. Y. Dept. of Health, 1932.

RECONSTRUCTION OF THE BILIARY TRACT. By Edmund Horgan. N. Y., Macmillan Co., 1932.

THOUSAND MARRIAGES (A). By Robert Latou Dickinson and Laura Beam. Baltimore, Williams & Wilkins Co., 1931.

TUMORS OF BONE. By Chas. F. Geschickter and Murray M. Copeland. N. Y., American Jnl. of Cancer, 1931.

UBER DIE NEURE ENTWICKLUNG DER CHIRURGISCHEN BEHANDLUNG DER LUNGENTUBERKULOSE. By R. Nissen. Berlin, Urban & Schwarzenberg, 1932.

VARICOSE VEINS. By H. O. McPheeters. Ed. 3, Rev. & Enl. Phila., F. A. Davis Co., 1931.

VERBANDTECHNIK. By Franz Hofmeister and Otto Jungling. Ed. 4, Berlin, Urban & Schwarzenberg, 1932.

WILHELM CONRAD RÖNTGEN UND DIE GESCHICHTE DER RÖNTGENSTRAHLEN. By Otto Glasser. Berlin, Julius Springer, 1931.

YELLOW FEVER. By Henry Rose Carter. Baltimore, Williams & Wilkins Co., 1931.

ZEITSCHRIFT FUR DAS KLASSISCHE ALTERTUM. By Albert Rehm and Johannes Stroux. Leipzig, Dieterich'sche, 1932.

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# PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

## SEVENTH INSTALLMENT

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## Chapter XXIII

# THE MEDIAN NERVE

In civil life injuries of the median nerve occur as the result of wounds produced by knife stabs; glass splinters; suicidal attempts by cutting the wrist; compression by a tourniquet, splint or cast; by prolonged compression in anesthesia or sleep; and by dislocation of the ulna or fracture of the radius. Injections of arsphenamine or other drugs may produce a partial or total paralysis. It is frequently involved in occupational atrophy and paresis. Likewise, cervical ribs have caused paralysis of this nerve. In the War lesions of the median nerve were observed by many to be second in number to the radial. They occurred chiefly as the result of gunshot wounds.

In contrast to the radial nerve, partial motor paralysis is often seen in incomplete lesions. The median nerve is remarkable for the frequency with which its injuries are painful. The cases may, therefore, be divided into the painless ones, complete and partial, and the painful ones.

### Motor Symptoms

When the median nerve has been divided completely or when all physiologic function has been lost, the hand inclines slightly to the ulnar side of the forearm. There is considerable atrophy of the muscles of the thenar eminence and the thumb is in the plane of the palm, producing the so-called "ape-hand" (Fig. 165). Pronation is incomplete and defective. When the forearm is flexed the patient supplements this defect by holding the elbow out. When it is extended he rotates the arm inward, and this results in passive pronation of the hand. Paralysis of the palmaris longus may be determined by palpation of its tendon at the bend of the wrist when flexion at the wrist is opposed. Paralysis of the flexor sublimis and outer part of the flexor profundus digitorum is manifested by

FIG. 165. Characteristic appearance of hands in median nerve lesions. Note ape-like appearance.

absence of flexion in the index finger and feeble flexion in the middle finger. This finger is usually influenced by the movement of the ring finger and at times the deep flexor may be

FIG. 166. Inability to make a fist in median nerve lesion.

Fig. 167. Inability to clasp hands in median nerve lesion.

supplied by the ulnar. These defects in flexion may be readily seen when the patient is asked to make a fist (Fig. 166). The

FIG. 168. Compare inability to oppose thumb and little finger in median nerve paralysis with that of a normal hand.

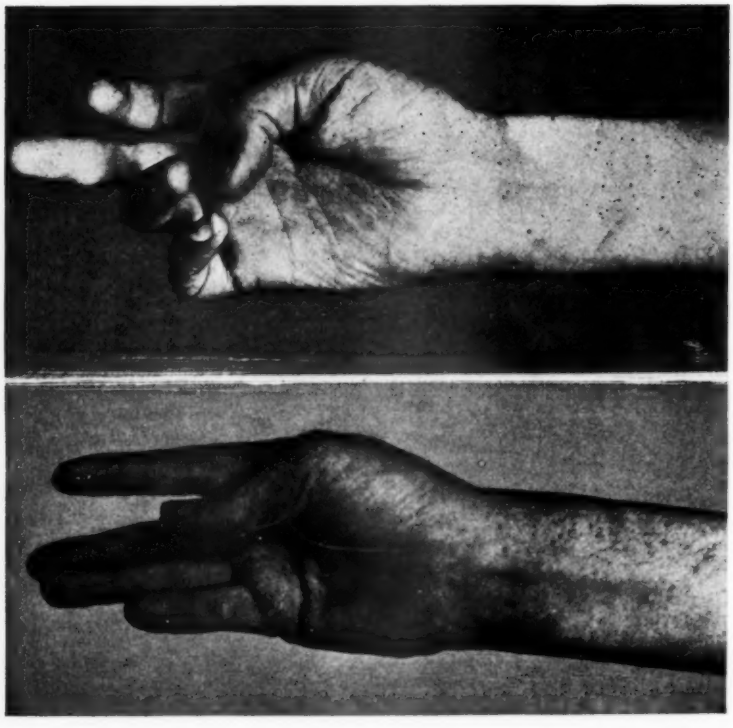

FIG. 169. Imperfect opposition of thumb in median nerve paralysis.

index and middle fingers will then be seen to have their phalanges only slightly flexed. The same defects may be observed by clasping the hands together as in prayer, when the index finger will remain extended (Fig. 167). Flexion of the proximal phalanges of the fingers may be carried out very well in spite of the paralysis of the lumbricales. Paralysis of the flexor longus pollicis makes it impossible to flex the distal phalanx of the thumb. Paralysis of the thenar muscles is shown by very defective opposition and abduction of the thumb at right angles to the palm (Figs. 168, 169).

SUPPLEMENTARY MOVEMENTS: In addition to the supplementary movements of pronation which have just been mentioned, others occur commonly in flexion of the proximal phalanges of the two outer fingers. The fact that the flexor profundus digitorum for the middle finger may in some instances receive its supply from the ulnar, explains the frequent presence of flexion of the first phalanx of that finger, inasmuch as the lumbricales have their origin in the tendon of the flexor profundus digitorum. If they are paralyzed, and especially if some contracture and shortening has taken place, contraction of the flexor profundus digitorum will produce a pull on the inert lumbricales and result in flexion of the proximal phalanges. That there is a pull exerted on the lumbricales seems to be shown by the fact that flexion of the proximal phalanx is stronger when combined with flexion of the terminal phalanges than when performed alone. The lumbrical muscle of the middle finger likewise receives its nerve supply from the ulnar. As was seen in paralysis of the extensors of the hand wherein flexion of the fingers produced a passive extension at the wrist, so under certain conditions the interossei may produce movements ordinarily subserved by the lumbricales. When extended the interossei produce a pull on the tendons of the flexor profundus and sublimis digitorum, and when the lumbricales are paralyzed, especially if these are shortened, passive flexion of the proximal phalanges will often occur. This mechanism permits full extension of the

terminal phalanges, and in median nerve lesions occurs in the middle and index fingers. It is to be noted that despite the paralysis of the flexors in a median nerve lesion, the position

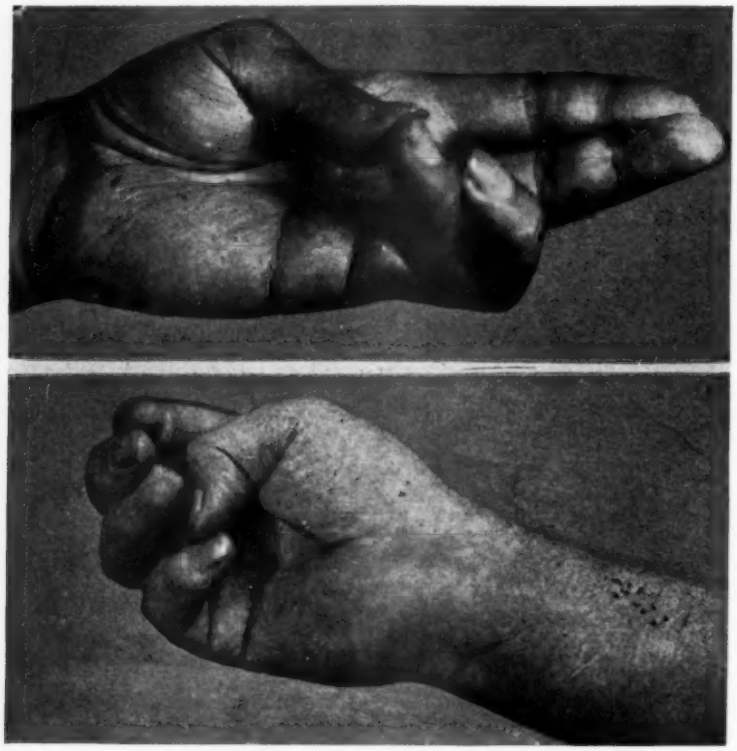

FIG. 170. Opposition of thumb in median nerve paralysis by supplementary muscle movements.

of the fingers is frequently one of flexion and not of extension. Flexion of the second phalanges of the two inner fingers occurs only a little weaker than normal as the result of the accompaniment of this movement to the normal flexion of the proximal and distal phalanges of these fingers. Flexion of the second phalanx of the middle finger is frequently present in this general flexor movement; first, because it is influenced by flexion of the ring finger and, second, because the flexor sublimis digitorum for this finger in some instances receives some of its nerve supply from the ulnar.

Flexion of the terminal phalanx of the index finger is always absent. Flexion of the terminal phalanx of the middle finger may be present in those cases in which the flexor profundus digitorum is supplied by the ulnar nerve. Extension of the wrist produces slight passive flexion of the fingers, which is better observed in combined lesions of the ulnar and median nerves. Flexion of the terminal phalanx of the thumb may be simulated by a rebound following extension of the phalanx. Opposition of the thumb to the little finger may be simulated by the action of the adductor pollicis combined with the inner head of the flexor brevis pollicis and flexion of the terminal phalanges of the little finger. It should be insisted upon that abduction, when tested, should occur at right angles to the palm (Fig. 170). When the metacarpophalangeal joint of the thumb is partially ankylosed so that no flexion or extension in the plane of the thumb is possible, traction of the extensor longus pollicis and the extensor ossis metacarpi pollicis produces abduction of the thumb at right angles to the palm.

### Sensory Symptoms

The large overlap of the radial nerve to the palm explains the dissociation of loss to epicritic and protopathic sensibility in median nerve lesions. The area of loss to tactile sensibility and to milder degrees of heat and cold follows closely the anatomic distribution of the median nerve. It occupies the radial side of the palm, the palmar surface of the thumb, the index, middle and, at times, the outer half of the palmar surface of the ring fingers, and the dorsal surface of the distal two phalanges of the index and middle fingers (Fig. 171). After a period of about forty days the loss to pain and to higher degrees of cold and heat shrinks so that in general it may be said that the loss to pain may occupy only part of the second phalanges of the index and middle fingers. The exclusive supply of the median nerve to pain sense was found to occupy the dorsal and palmar surfaces of the distal phalanges of the index

and middle fingers, the ulnar half of the palmar surface of the second phalanx of the index finger, part of the ulnar portion of the distal half of the second phalanx of the middle finger

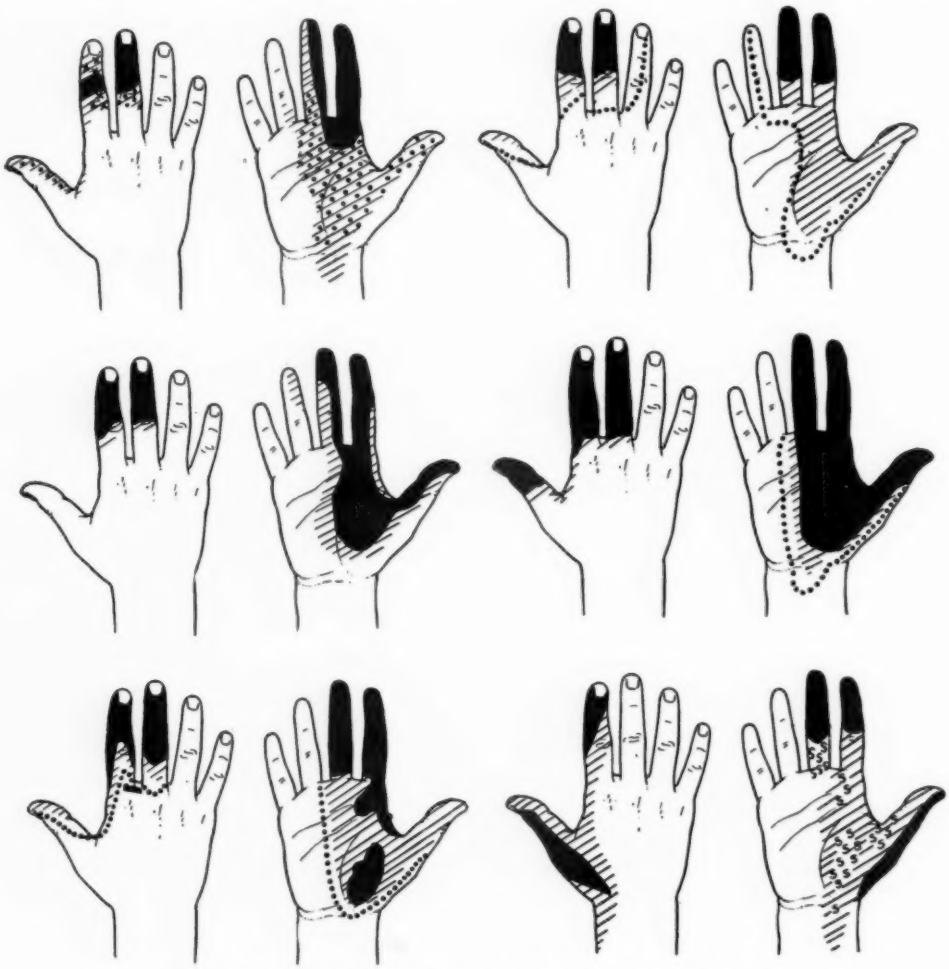

FIG. 171. Types of loss of sensation in median nerve lesion.

and the dorsal surface of less than half of the second phalanges of the index and middle fingers (Fig. 172).

The area of *residual sensibility* of the median nerve was obtained from cases of an ulnar and internal cutaneous lesion; a radial; a combined radial and median lesion; and cases of combined radial and ulnar lesions. The inner border on the

palmar surface was obtained by the method of residual sensibility from an ulnar and internal cutaneus lesion. On the dorsal surface we were compelled to employ another method

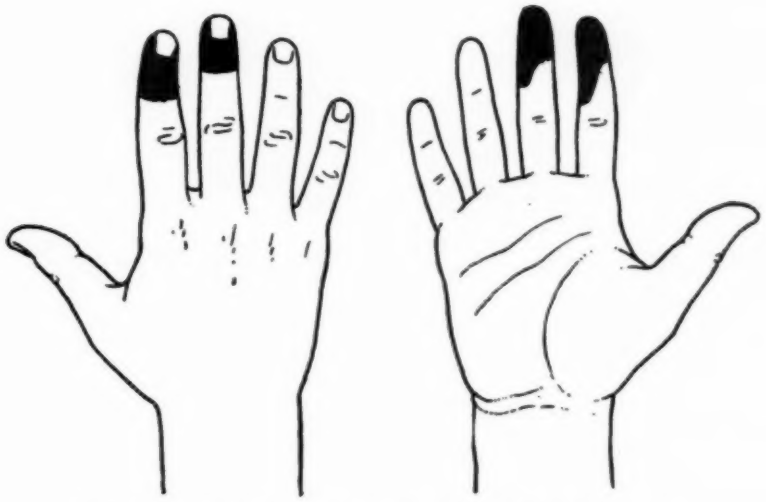

FIG. 172. Isolated supply to pain sense of median nerve.

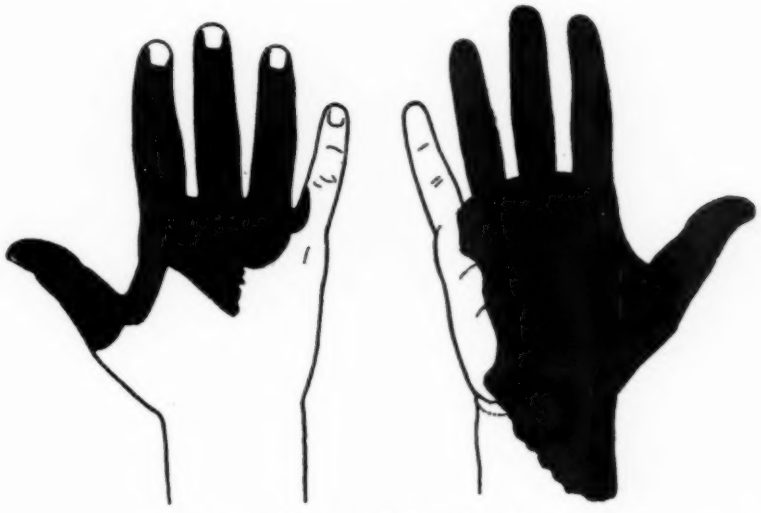

FIG. 173. Residual sensibility of median nerve.

since the cases of combined ulnar and radial lesions were too recent to have had return of prick pain due to overlap. The border of overlap of the musculocutaneus to the radial was

obtained by means of residual sensibility in a case of combined radial and median. Inasmuch as the radial has no isolated supply to prick pain, this border separates the musculocutaneous from the median overlap. We, therefore, used this border as the proximal border of the median overlap to the radial nerve. We were supported in doing this in those cases which showed an area of analgesia between the areas of overlap of the median and musculocutaneous nerves. Part of the inner border of the overlap on the dorsum of the hand is hypothetical and is shown as a rough border (Fig. 173).

Sense of position is often lost in the index finger and vibration sense is lost in the distal phalanges of the index and middle fingers. Because of the paralysis and the defective sensibility it is difficult for the patient to recognize objects placed in his hand. In complete lesions pinching the distal phalanges of the index and middle fingers never gives rise to sensation, whereas it is always produced in partial or incomplete lesions.

### Vasomotor Symptoms

The skin of the palm in median nerve lesions often is discolored, purplish, cyanosed, cold or red. The skin is dry and chapped and at times keratotic. Although Bénisty has never seen a case uncomplicated by vascular damage in which the nails showed any change, in our experience ridging and hypertrophic nail-beds were often seen (Fig. 174).

So-called trophic ulcers were commonly observed, especially on the distal phalanx of the index finger, where they usually occurred as the result of a burn by a lighted match. Once injured, the skin and subcutaneous tissues were sluggish in healing and ulceration resulted.

### Level of the Lesion

A lesion of the median nerve in the middle of the forearm may paralyze the superficial flexor of the index finger while allowing those of the other three fingers to escape. The palmar

FIG. 174. Trophic changes in median nerve lesions.

muscular branch arises at the level of the trapezoid ridge, or the lower edge of the annular ligament. The highest branch given off from the median is that to the pronator radii teres in the outer cubital space.

## Partial Lesions

Bénisty states that in partial lesions flexion of the index finger is the most defective movement, though opposition of the thumb is very poor as well. There is frequently imperfect flexion of the middle finger and of the second phalanx of the thumb. The pronators and flexors of the wrist are either not affected at all or are very slightly paretic.

Of 16 cases seen in the U. S. General Hospital No. 28 after injury of the median in the arm, the opponens was paralyzed in 8 cases; all were weak in 7 cases; the flexor of the thumb was paralyzed in 4 cases; the flexor of the index finger in 3 cases; and the palmaris longus in one case. Of 11 cases injured in the forearm, the flexor of the index finger was paralyzed in 5 cases; all muscles were weak in 4 cases; the flexor of the thumb, the abductor of the thumb and the opponens were paralyzed in 2 cases each, and the palmaris longus in one case. As in Bénisty's material, when dissociated paralysis occurred the flexor of the wrist was rarely affected. However, the opponens seemingly was more severely and more frequently affected than the flexor of the index finger in lesions of the arm. Further reference to this will be made under residual paralysis. In lesions of the forearm, the flexor of the index finger was more frequently involved.

In an analysis of the records in the Surgeon General's office representing all of the American material, of 59 cases of partial lesions in arm injuries, all muscles were weak in 33 cases; the small hand muscles were paralyzed in 9 cases; all muscles were paralyzed in 7 cases; the flexor of the index finger in 7 cases; the flexor of the thumb in 3 cases; the abductor of the thumb in 2 cases; the opponens in 2 cases; and the palmaris longus in one case.

Of 56 cases with injury in the forearm the small hand muscles were paralyzed in 31 cases; all were weak in 15 cases; all were paralyzed in 5 cases; the flexor of the index finger in 5 cases; the flexor of the thumb in 2 cases; and the abductor of the thumb in one case. It will be noted that the small hand muscles are most frequently paralyzed and next to them the flexor of the index finger. In lesions in the forearm paralysis in the small hand muscles is more frequent because the lesion is below the point where the fibers to the flexor of the fingers are given off.

Of 25 cases of partial lesions which were sufficiently severe to warrant operation in arm injury, all of the muscles were paralyzed in 9 cases; all were weak in 7 cases; the small hand muscles were paralyzed in 6 cases; the flexor of the index finger in 5 cases; the flexor of the thumb in 2 cases; the abductor of the thumb in 2 cases; and the flexor carpi radialis in one case. Of 17 similar cases of injury in the forearm the small hand muscles were paralyzed in 7 cases; all were weak in 6 cases; all were paralyzed in 4 cases; and the flexor of the index finger in one case. It will be noted that whether severe or not, the order of frequency of paralysis of certain muscles is the same.

Sensation is rarely lost completely in partial lesions of the median nerve, in contrast to ulnar nerve lesions. Unless complete physiologic interruption of function was present, the loss to touch and pain was coextensive, and when recovery to pain occurred touch sensibility likewise returned.

Physiologic interruption cannot be differentiated from anatomic section by the strength of the movements of the phalanges of the fingers. Although in a considerable number of cases the movements of the index fingers were stronger, this could not alone determine the character of the lesion. Return of function in the opponens pollicis would indicate a partial or recovering lesion, but because of supplementary motility it is difficult to determine.

Sensory regeneration or incomplete sensory loss in the area supplied by the median nerve is almost constant in

incomplete lesions and in otherwise physiologically complete ones; i.e., partial lesions sufficiently severe to come to operation. In a large proportion of partial or recovering lesions

FIG. 175. Marked atrophy in median nerve paralysis.

sensory regeneration is present when motor phenomena give no indication of regeneration.

## ATROPHY

Marked flattening of the outer part of the thenar eminence is seen in the early stages of the injury, and after some months the group of muscles originating from the inner condyle likewise are atrophied. In the thenar eminences the head of the first metacarpal bone is seen prominently under the skin (Fig. 175).

## SIGNS OF MOTOR RECOVERY

Bénisty believes that recovery of function of the muscles in lesions of the median nerve takes place in complete and partial paralysis in very much the same way. The pronator and palmar muscles regain their functional activity first, then the flexors of the middle finger and afterward the flexor of the thumb. Flexion of the index finger and opposition of the thumb are impaired for a very long time.

Stopford's statistics show that in 14 cases of suture of the median nerve in the lower third of the forearm the abductor brevis pollicis recovered first in 5 cases. Of 10 cases of injury

to the nerve at the bend of the elbow above the origin of the motor branches, in one case the pronator and flexor carpi radialis recovered first, and in 3 cases the abductor brevis pollicis. In 8 cases of suture of the nerve in the arm, the pronator, flexor carpi radialis and the palmaris longus recovered in one case and the abductor brevis pollicis in 3 cases.

From the Surgeon-General's material of 12 cases of injury to the nerve in the arm which recovered spontaneously, there was return of function in the flexor of the index finger in 7 cases; in the flexor carpi radialis in 5 cases; in the flexor of the thumb in 5 cases and in the small hand muscles in one case. Of 9 cases of injury in the forearm, there was return of function in the flexor of the index finger in 5 cases; in the flexor carpi radialis in 2 cases; and in the small hand muscles and abductor of the thumb in one case each. Following suture of the nerve in the arm in 15 cases, there was a return of function in the index finger in 8 cases; in the flexor carpi radialis in 8 cases; in the flexor of the thumb in 2 cases; and in the opponens in one case. Of 9 cases in which the nerve was sutured, there was a return of function in the flexor of the index finger in 4 cases; in the flexor of the thumb in 2 cases; and in the flexor of the wrist in one case.

The large number of cases which showed return of function in the flexor of the index finger may in part be due to an error because of misinterpretation of supplementary motility. Ignoring this muscle, it may be seen in these cases that the flexors of the wrist and of the thumb recover first. This differs from Stopford's figures in the few cases of recovery of the abductor of the thumb.

Further light may be thrown upon the problem in a study of residual paralysis. Of 18 cases of injury to the nerve in the arm residual paralysis remained in the flexor of the index finger in 11 cases and in the small hand muscles in 12 cases. Of 12 cases of injury in the forearm, residual paralysis remained in the small hand muscles in 8 cases and in the flexor of the index finger in 6 cases. It is evident that even if recovery does

*begin* early in the flexor of the index finger, it is very late in its completion. When recovery occurs in the small hand muscles the opponens is the last to recover (Fig. 176).

FIG. 176A.

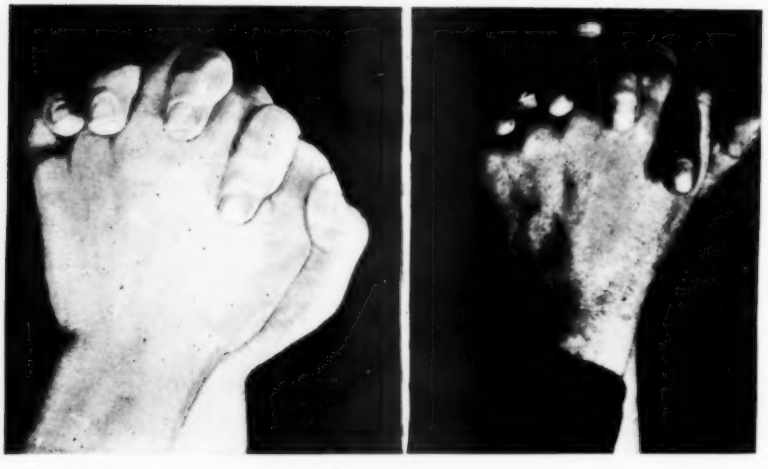

FIG. 176B.

FIG. 176. Recovery of median nerve indicated by partially and completely clasping hands and making a fist.

Complete recovery of motor function may be tested further, as pointed out by Pitres, by having the patient scratch the

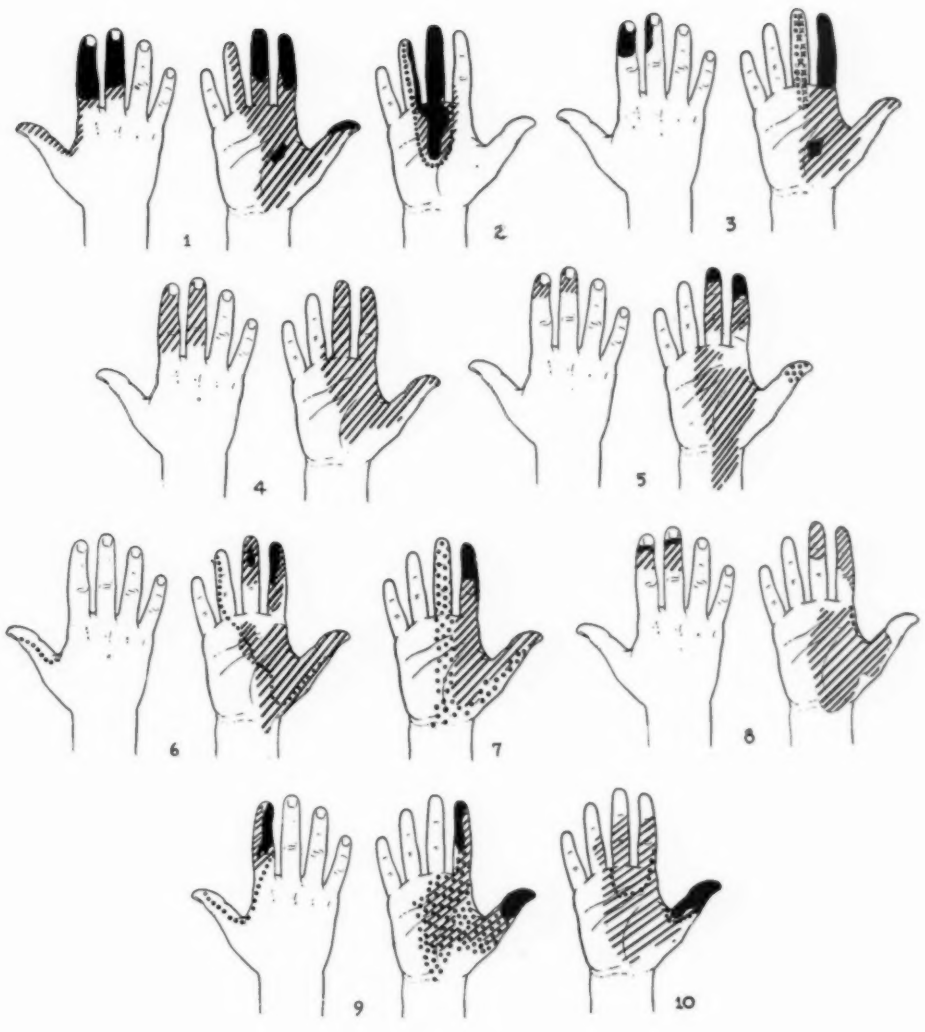


FIG. 177A.

A. Spontaneously recovering median nerve lesion. 1. Motor recovery, severe sensory loss. 2. Unusual distribution of sensory loss. 3. Recovery of touch but not of pain or cold. 4. Recovery of pain and cold, but not touch. 5 and 6. Patchy recovery of touch. 7. Recovery of touch and pain but not cold. 8. Patchy recovery of touch; complete recovery of pain and cold. 9. Recovery of touch and pain, but not cold. 10. Recovery of cold but not of touch.

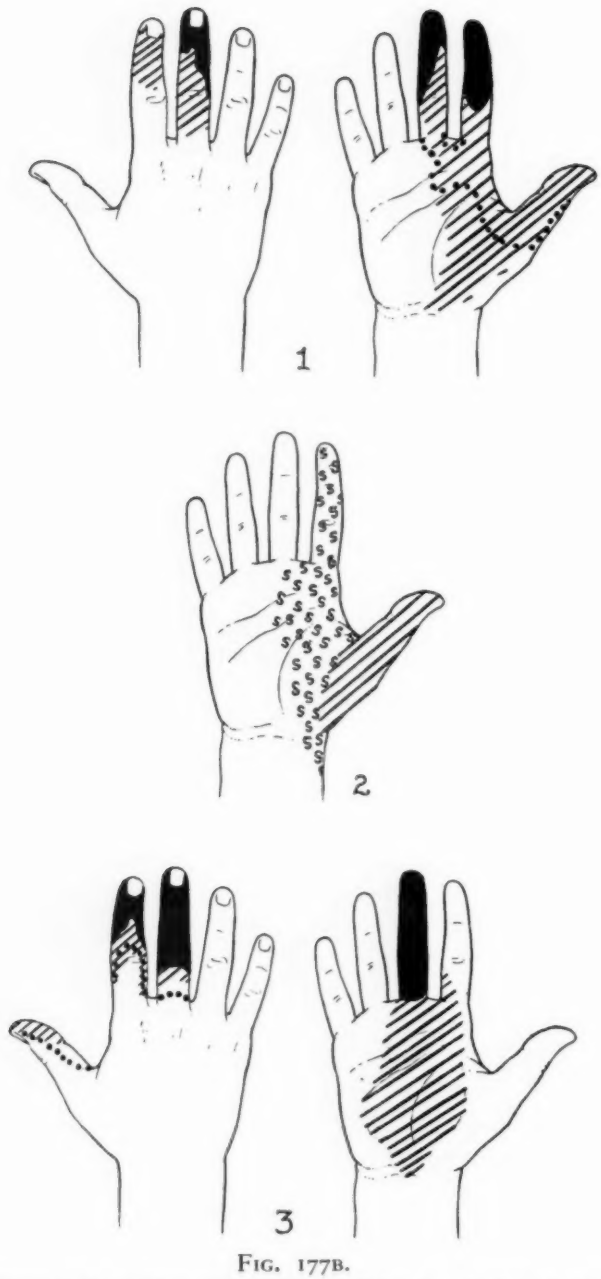


FIG. 177B.

B. Median nerve lesions after operation. 1. Slight interlacing of cold; recovery of cold, not touch; end-to-end suture. 2. Nodule excised, recovery of pain in isolated supply of nerve; diminished tactile loss. 3. Neurolysis, no analgesia or anesthesia of volar surface of index finger.

table with his index finger with the palm lying flat upon the table.

## Signs of Sensory Recovery

The sensory recovery generally begins before motor function returns, but it remains defective for a long time, particularly in the index finger. In certain instances the return of protopathic sensibility has been interpreted as evidence of regeneration. This has led to the belief that the resulting "hyperpathic" sensations are a sign of recovery, whereas the opposite is true. After true sensory regeneration occurs the paresthesias and over-response to stimuli progressively diminish. On the other hand, when deep pressure is exerted over the area of isolated supply in the distal phalanges of the index and middle fingers, diffuse pain may be elicited during regeneration. In examining for Tinel's sign one may likewise evoke greater pain than in lesions of any other nerve. The same general observation, that interlacing of areas of sensory loss and return of sensation to any one or another type of stimuli in the isolated supply of the nerve is an indication of sensory recovery, holds true (Fig. 177).

Median nerve lesions which recovered spontaneously showed in a number of instances areas of return of sensibility to touch and not to cold. More frequently, cold had returned in areas whereas touch had not. Interlacing of the border of loss of cold was seen. Patchy return of tactile sense and pain sense was observed. Partial lesions often showed a sensory loss in only part of the sensory supply of the nerve. As a rule, the cases which recovered after operation showed less recovery to pain. When motor recovery had begun sensory recovery could often be seen.

## Painful Lesions

A very large number of lesions of the median nerve are characterized by the predominence of pain. This painful type

of lesion was first noted during the American Civil War by S. Weir Mitchell, who described its intensity and character under the name of *causalgia* (Fig. 178).

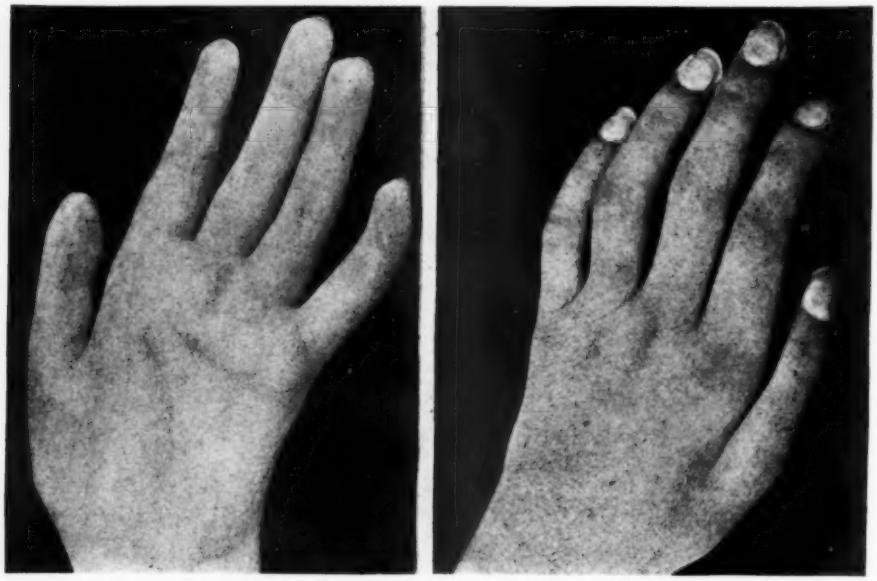

FIG. 178. Causalgia in median and ulnar nerve lesion.

The motor disturbances are usually slight, and total paralysis of all the muscles below the level of the wound is of rare occurrence. However, some weakness in movement is always present. This is commonly localized in the flexors of the fingers but particularly the index finger and the thenar muscles. Much of the weakness is due to the pain, which is increased upon movement. Involuntary movement consisting of an irregular tremor of the thumb and index finger, but noticeable in all the fingers, is characteristic of these painful lesions, which are described in detail in the chapter on Causalgia.

## DIFFERENTIAL DIAGNOSIS

At times a differential diagnosis may be necessary in civil life when paresis and atrophy of the muscles supplied by the median nerve may be the result of cervical ribs, syringomyelia

or other disease of the anterior grey matter of the spinal cord. In general, it will be found that all of the signs of a median nerve palsy will not be present. For example, preservation of the function of one of the muscles, as the palmaris longus, may be present, or the sensory loss present follows a root or cord segment distribution. On the other hand, there may be no sensory loss at all. In addition, signs not explainable by a median nerve lesion will be present, such as a Babinski sign or a contralateral analgesia of the trunk or body.

In the War, injury to tendons and muscles, painful joints, hysterical paralysis and "congealed" hands required differentiation. Several characteristic signs of motor disability always were present in median nerve lesions. The thumb was in a position in the plane of the palm; the thumb could not be opposed to the little finger so as to make the letter "O." When making a fist the index finger remained partly extended and the terminal phalanx of the thumb was not flexed. The same was true when clasping the hands as in prayer. In general, both in congealed hands and hysterical paralysis, electrical reactions are normal. Muscles are involved which are not innervated by the median nerve, and others which are so innervated are spared. The sensory loss, if present, does not conform to the anatomic distribution of the median nerve, and no area of overlap to painful sensibility is ever found. The borders of the sensory loss which is present shift with each examination.

## Anatomy

The median nerve has two heads of origin, one lateral and one medial, which unite at the lower border of the pectoralis minor muscle to form the main trunk of the nerve. The external head of origin consists of fibers derived from the lateral cord of the brachial plexus, which in turn consists of the anterior divisions of the fifth, sixth and seventh cervical spinal nerves. The medial head of origin consists of fibers derived from the medial cord of the brachial plexus which is made up

of the anterior divisions of the eighth cervical and first thoracic nerves. Thus all of the spinal nerves which contribute to the formation of the brachial plexus are represented in the parent trunk of the median nerve.

Most commonly the lateral head of the nerve lies lateral to the axillary artery and the internal head crosses it but many variations in this relationship and in the origin of the nerve may occur and most of them have been described. There may be a reduplication of the two heads of origin or a third root of origin may arise from the medial cord. Occasionally the heads of origin may not unite to form the median trunk until they have reached the middle of the arm or even as low as the elbow. The lateral head of origin may pass behind the axillary artery to join the medial head and Turner has described the opposite condition.

As the trunk of the nerve descends below the inferior margin of the pectoralis minor muscle, it is separated from the anterior surface of the subscapular muscle by the axillary artery. The nerve is in apposition to the anterolateral surface of the artery and Cruveilhier has called attention to the imprint of this relationship upon the posterior surface of the nerve. The musculocutaneous nerve with its two branches to the coracobrachialis muscle lies lateral to the median trunk. The ulnar is placed more deeply and lies medial to the median, between the axillary artery and vein. The pectoralis major muscle covers the nerve in front and the coracobrachialis partially hides it on its anterolateral surface.

As it leaves the axillary space the nerve crosses the anterior surface of the artery although it may lie behind it, run parallel to it or pass either lateral or medial to it. At this level the median receives nutrient vessels from the brachial artery. Anterolaterally the nerve is pressed close to the coracobrachialis muscle and it follows closely the internal border of the biceps. Medially, the nerve and brachial artery are covered only by the brachial aponeurosis and skin. This may form a veritable aponeurotic canal (Cruveilhier). (Fig. 179.)

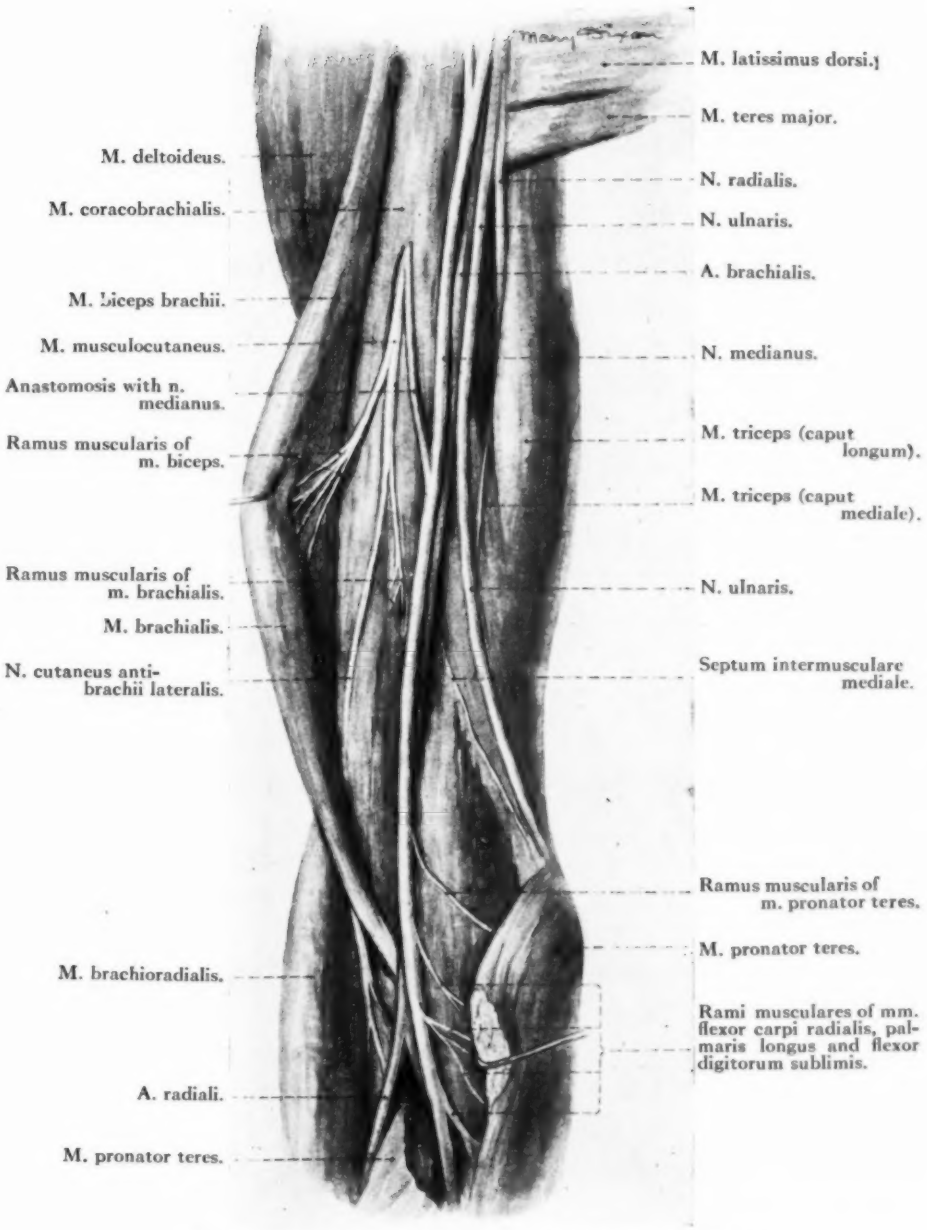


FIG. 179. Anatomical course of median nerve in arm.

Just above the elbow the median lies upon the anterior surface of the brachialis anticus muscle. It gradually leaves the brachial artery which comes to lie lateral to the nerve. The brachial aponeurosis and an extension of the aponeurosis about the biceps tendon covers the median anteriorly. The vein and the branches of the medial cutaneous nerve to the arm lie in the subcutaneous tissue superficial and medial to the nerve. The median then passes between the two heads of origin of the pronator teres muscle. The collateral branches of the brachial artery are intimately related to the nerve at this level.

In the forearm the course of the median actually justifies its name. It descends in the middle of the anterior aspect of the forearm in the fascial plane between the flexor digitorum sublimis and the flexor digitorum profundus muscles. As the ulnar artery passes from its site of origin from the brachial it passes posterior to the median in an oblique direction to reach the medial aspect of the forearm. As the tendons of the two large flexor muscles of the fingers arise the median lies directly upon the tendon to the index finger. The tendons to the middle, ring and little fingers lie medially and the palmaris longus tendon lies anteriorly. Hartmann has called attention to the fact that the nerve may be reduplicated in its course in the forearm (Fig. 180).

As the median approaches the wrist, it follows along the under surface of the flexor sublimis digitorum. It again becomes superficial, lying under the palmaris longus tendon, for which it has been mistaken commonly. The flexor carpi radialis tendon lies laterally. The median, contrary to the ulnar nerve, passes below the anterior annular ligament into the palm, where it lies beneath the palmar fascia. Here it divides into its terminal digital branches.

The median nerve gives off no branches in the arm except in the lower third near the elbow. A small branch may be given off to supply the elbow joint (Rudinger). Frohse and Fränkel state that this nerve may end within the brachialis

FIG. 180. Anatomical course of median nerve in forearm.

*a*, N. medianus. *b*, Tendon of m. biceps. *c*, A. brachialis. *d*, Ramus superficialis n. radialis. *e*, M. brachioradialis. *f*, A. radialis. *g*, M. flexor carpi radialis. *b*, N. medianus. *i*, M. abductor pollicis longus. *k*, M. abductor pollicis brevis. *l*, M. flexor pollicis brevis. *m*, M. brachialis. *n*, M. pronator teres. *o*, M. palmaris longus. *p*, N. interossei. *q*, M. flexor digitorum sublimis. *r*, Tendon palmaris longus. *s*, M. flexor carpi ulnaris. *t*, A. ulnaris. *u*, N. ulnaris. *w*, M. palmaris brevis. *x*, Ramus superficialis n. ulnaris. *y*, Palmar aponeurosis.

anticus muscle. Also at this level one or two branches may supply the humeral head of the pronator teres muscle. In many instances the median nerve communicates in a variable manner with the musculocutaneous nerve.

As the median reaches the antecubital fossa it gives off branches to the pronator teres muscle, usually three in number. They may be contained in a single sheath, dividing immediately before entering the muscles, after having a short extramuscular course.

The next branches given off are to the palmaris longus, flexor carpi radialis and flexor sublimis digitorum in that order. At about this level a branch is given off to supply the deep flexor group of muscles. It arises from the ulnar side of the dorsal surface of the nerve, descends in that position and gives off twigs to the flexor digitorum profundus muscle for the second and third fingers and to the flexor pollicis longus. This branch is known as the *anterior interosseous* nerve and is accompanied in its course by the anterior interosseous artery. It lies deeper than the main trunk in front of the interosseous membrane in the cleft between the flexor digitorum profundus and the flexor pollicis longus. It gives off additional branches to these muscles at a lower level. It ends upon the deep surface of the pronator quadratus muscle, which it supplies, and gives off a branch to the wrist joint.

A few centimeters above the anterior annular ligament the median gives off a palmar cutaneous branch. It arises from the lateral side of the main trunk, descends with it and sometimes is masked by it. It becomes quite superficial, passes over the anterior annular ligament and divides into a lateral and a medial termination to supply the palmar surface of the skin over the radial portion of the palm.

Just below the annular ligament the median gives off a muscular branch which supplies the abductor pollicis, opponens pollicis and flexor brevis pollicis muscles. Within the palm, the median divides into five terminal twigs which pass between the palmar arch and the flexor tendons. These

branches supply the skin over the radial and ulnar sides of the thumb, the radial and ulnar sides of the middle finger and the radial side of the ring finger as the digital nerves. These terminal branches also supply the first and second lumbrical muscles.

Hartmann, Longet and others have shown that the digital branches of the median give off collateral twigs which anastomose with the digital branches of the radial and form a real plexus about the terminal phalanges of the index, middle and ring fingers. Stopford has called attention to the fact that branches of the median innervate the interphalangeal articulations of the thumb, index and middle fingers. Cruveilhier, Sappey, Morel and Duval, Frohse and Fränkel among others have shown that there may be an anastomosis between the deep branch of the ulnar and the thenar branch of the median. Gegenbaur has demonstrated that the abductor pollicis may be the only muscle of the thenar eminence innervated by the median; the remainder receive their supply from the ulnar. Goldman, Auerbach and Brodnitz, and Stookey have called attention to the opposite condition, in which the innervation of all of the intrinsic hand muscles comes from the median nerve. The innervation of the lumbrical muscles may be irregular. Cruveilhier, Froment and Tumer state that the median may alone innervate the third lumbrical or it may receive branches from both the median and ulnar.

The median may have a branch of communication with the musculocutaneous nerve in the arm and with the ulnar in the forearm. The latter is said by Thompson to occur in about 15 per cent of 406 specimens. This may take place between the trunks of the two nerves; between the anterior interosseous nerve and the ulnar; between a branch of the median trunk, which arises near the elbow, passes over the flexor muscles arising from the medial condyle and the ulnar in its middle third; or by a communication between a branch of the median and a branch of the ulnar. The median may give a branch to the flexor muscles of the fourth and fifth fingers but the ulnar

nerve innervates the flexor muscles of the index finger. These anomalies of innervation and anastomoses should be kept in mind because they may help to explain certain clinical phenomena seen in the course of lesions of the median nerve.

## Physiology

The muscles innervated by the median nerve have the primary physiological function described in the following paragraphs.

The *pronator teres* muscle pronates and flexes the forearm. The *pronator quadratus* also pronates the forearm strongly. The *flexor carpi radialis* flexes the radial portion of the hand but imparts to it no lateral movement. The *abductor longus pollicis* weakly flexes the hand. Complete flexion of the hand is accomplished by the coordinated action of all of these muscles. The *flexor sublimis digitorum* flexes the second phalanx upon the first, while the terminal phalanx remains extended. The *flexor digitorum profundus* flexes the terminal and second phalanges upon the first. Complete flexion of the fingers is possible only when the extensors of the wrist are fully contracted. Likewise the flexors of the fingers contract sharply but involuntarily when the wrist or fingers are extended voluntarily. The *flexor pollicis longus* flexes only the terminal phalanx of the thumb.

The *first* and *second lumbricales* act like the interossei into which they are inserted; they produce flexion of the first phalanges and extension of the second and terminal phalanges. The *opponens pollicis* flexes the first metacarpal on the wrist and at the same time draws it inward. The *abductor pollicis* and *outer head* of the *flexor brevis pollicis* produce a movement of the first metacarpal similar to that of the opponens. However, in addition, they extend the second phalanx and tip the first phalanx on its outer side, thus revolving it on its axis from without inward. Thus the tip of the thumb is opposed to the tips of the index and middle fingers. The *outer head* of

*flexor brevis pollicis* aids in opposing the thumb to the ring and little fingers. It tips the first metacarpal and the first phalanx of the thumb toward the little finger.

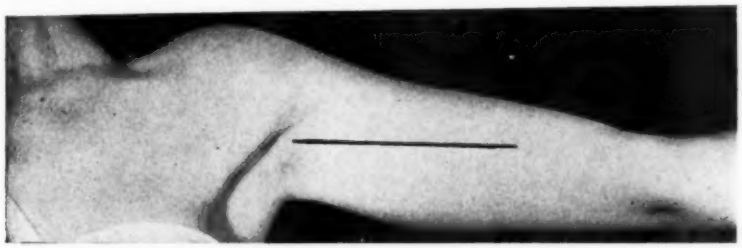

FIG. 181. Line of incision to expose median nerve in arm.

## SURGERY

The median nerve like the ulnar is seldom injured alone in the axilla or upper arm. With the arm abducted and the forearm flexed, an incision is made along the medial border of the coracobrachialis muscle above the biceps below. If the extremity is extended fully, the median is placed upon stretch and in large, muscular individuals it may be hidden beneath the border of the biceps. If necessary the median may be exposed upward as far as the junction of its lateral and medial heads, by retracting the pectoralis major muscle (Fig. 181).

The axillary artery and vein commonly are injured with the median in the arm and care should be taken to prevent serious bleeding, particularly if the lesion is accompanied by a large amount of scar tissue. Torsion of the trunk of the nerve should be prevented here as elsewhere by placing identification sutures. The motor branch to the pronator teres muscle is the only structure which allows of an anatomic surface identification and this is utilizable only in lesions near the medial condyle. It is extremely important to visualize the antecubital fossa in attempting to expose the median at the elbow. The arm should be in abduction and external rotation with the forearm in complete supination. The base of the fossa is an imaginary line between the humeral condyles. Its medial wall is the lateral edge of the pronator radii teres muscle and its

lateral wall is the medial edge of the brachioradialis muscle. The biceps tendon passes through the lateral side of the fossa. The median nerve and brachial artery rest on the floor of the

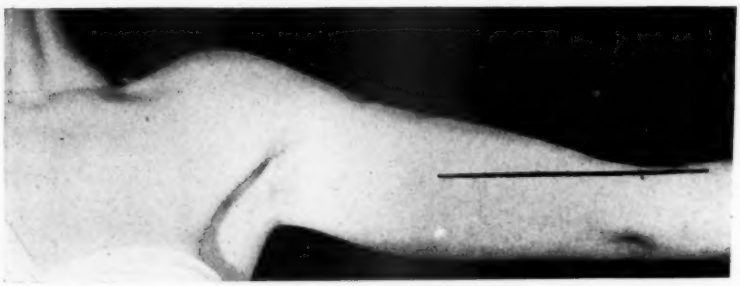

FIG. 182. Line of incision to expose median nerve at elbow.

fossa which is formed by the brachialis anticus. To expose the nerve, one should identify the medial border of the biceps and its tendon. The median lies medial to these structures (Fig. 182).

A trifle lower the median passes between the two heads of the pronator teres and it is necessary to cut this muscle to expose the nerve adequately. This should be done very carefully to avoid injury to the motor branches which are given off at this level. The pronator teres may be divided near its humeral origin or at its tendinous insertion into the radius. In the latter case the radial nerve and artery must be isolated and injury to them avoided. After the pronator has been divided, the flexor carpi radialis is retracted medially. This exposes the flexor sublimis digitorum and its tendinous arch of origin which practically is the key to the operative field at this level. The median nerve and ulnar artery pass beneath this arch. The head of origin of the superficial flexor from the radius should be divided. The muscle may be retracted medially with the pronator and the median will be exposed in its entire length throughout its deeply placed portion upon the anterior surface of the flexor digitorum profundus. Injuries to the median at this level offer serious surgical difficulties because both the motor branches and the trunk may be

involved. Careful dissections and surgical conservatism are extremely important.

Exposure of the median in the forearm may be obtained

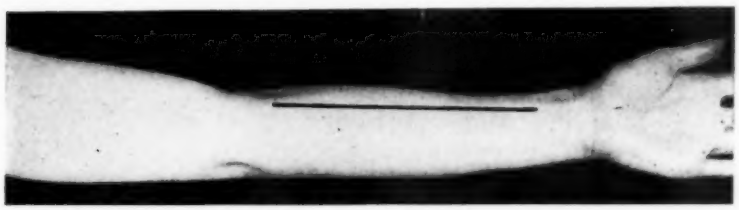

FIG. 183. Line of incision to expose median nerve in forearm.

by an incision from the medial side of the insertion of the biceps tendon in a line to the insertion of the flexor carpi radialis tendon (Fig. 183). At the junction between the middle and lower thirds of the forearm the median lies at a deeper level than it does at the wrist. It may be exposed by retracting the edge of the flexor carpi radialis muscle laterally. This will expose the aponeurotic medial edge of the flexor pollicis longus and the median lies in a cleft between this muscle and the flexor digitorum sublimis.

Lesions of the median nerve at the wrist are usually associated with division of the flexor tendons. Consequently great care should be used in identifying each structure. It is essential to identify the palmaris longus tendon and likewise that of the flexor carpi radialis. Little difficulty should be encountered in differentiating between the median nerve and the palmaris longus tendon. It is surprising, however, how often one finds the end of this tendon sutured to the end of the median. The tendon is more cylindrical, more compact and is of a pearly white glistening color. The nerve is dull and more grey in appearance. If this difference in appearance is uncertain, electrical stimulation will definitely help in the differentiation.

If difficulty is experienced in identifying the upper end of the nerve it may be of help to follow up along the edge of the flexor carpi radialis tendon. If the lesion is low it may be

necessary to divide the annular ligament and palmar fascia. The nerve may be identified as it passes along the radial side of the superficial flexor tendons. The anterior surface of

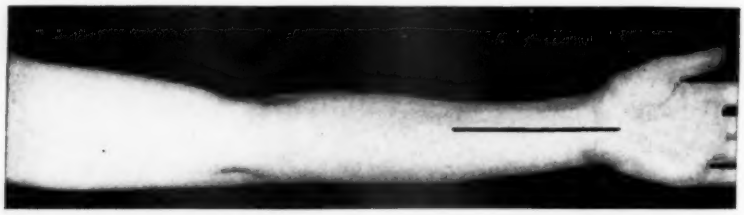

FIG. 184. Line of incision to expose median nerve at wrist.

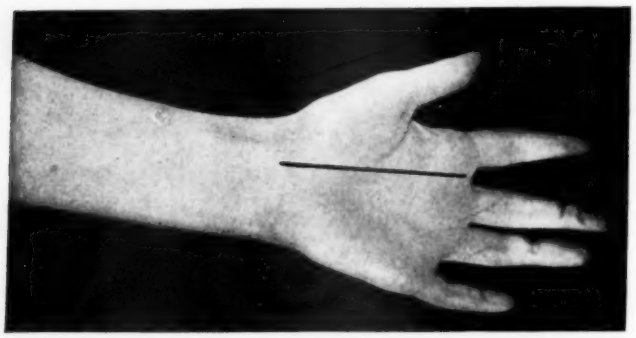

FIG. 185. Line of incision to expose median nerve in palm.

the nerve at the wrist frequently is marked by the small but distinct artery to the median nerve which passes along in its sheath. Prevention of axial rotation is as important at this level as elsewhere, even though the majority of the fibers are sensory in function (Fig. 184).

Exposure of the median in the palm may be obtained by an incision from the insertion of the palmaris longus tendon into the palmar fascia to the web between the index and middle fingers (Fig. 185). The palmar fascia must be divided and the flexor tendons identified. Near the wrist the median lies on the radial side of these tendons. The branches to the thenar muscles must be carefully preserved. The nerve passes below the superficial palmar arch and divides into its digital terminations. Only occasionally is it possible to effect a suture of these terminal branches. Suture of the nerve lower in the palm is

practical and may be accomplished with patience and exactness in dissection.

Continuity defects in the median nerve may be overcome in many instances by primary suture of the neuromatous ends and consequent stretching followed by secondary resection of the neuromas and end-to-end suture. Flexion relaxation of the elbow and wrist joints may bridge a considerable gap. The median may be transposed above the pronator teres, by carefully dissecting the motor branches free and isolating them to a point some distance above the medial condyle. A defect may be shortened 6 to 8 cm. by this procedure and flexion of the forearm.

Defects which cannot be bridged in this manner present a real surgical problem for repair. One may have to have recourse to autogenous grafts taken from the superficial branch of the radial nerve or to a suture between this nerve and the median. The results of such procedures are so unsatisfactory that it is necessary to use every effort to obtain an end-to-end suture. The incision may be extended into the arm or axilla in an attempt to obtain mobilization.

In concomitant tendon injuries at the wrist, each tendon must be isolated and both ends identified. They should be resutured carefully. If distortion of the original tendon patterns is necessary, then tendon anastomoses of similar physiological types should be made. The median nerve should be sutured after these steps have been taken.

### Treatment of Causalgia

Since the pathogenesis of causalgia is not understood thoroughly, it is not surprising that the surgical treatment for the relief of this excruciating pain has been extremely varied and not uniformly successful. The information obtained by some of these attempts at surgical relief have helped to elucidate the pathology of this painful lesion.

Gosset operated upon several of the patients with causalgia in the service of Pierre Marie. In some instances the involved

nerve was slightly swollen or indurated and quite grey over a considerable distance. In other cases the nerve was found to be edematous and red or constricted by a rather tight fibrous band. Under these conditions the nerve was simply liberated but this procedure has no effect whatever upon the severity or course of the pain. In one case the swelling upon the nerve was torn apart and this was followed by complete relief of the pain within a week.

Sicard was the first to inject alcohol into the nerve trunk for the relief of causalgia. He recommended 60 per cent alcohol which he stated produces anesthesia but not paralysis. He reported twenty-one cases of his own; nine treated by Pitres; two reported by Gunda and seven by Godelewski, all of which were relieved by this treatment. Sicard injected about 3 cc. of 60 per cent alcohol with a very fine needle into the nerve trunk. The injection should be made 3 to 4 cm. above the lesion so that all collateral branches are reached. He states that in several instances pain was not relieved because the injection was made below or within the lesion. This procedure should be accompanied by the liberation of the nerve from all scar tissue and reconstruction of a new bed for the nerve. Pitres and Marchand have reported corroborative evidence to support this method of treatment. The strength of alcohol used for injection must be determined largely on one's decision as to how prolonged an action is desired. It is well known that the action of alcohol upon the fifth nerve, when it is injected for the relief of trigeminal neuralgia, is only temporary though absolute alcohol is used. Consequently it may be assumed that a peripheral nerve will recover its function proportionately sooner if 60 per cent alcohol is injected. If the pain does not recur with recovery of function then it may be assumed that some natural process of healing has occurred. It is therefore necessary that each surgeon judge each case individually to determine the percentage of alcohol to be used. Sixty per cent alcohol has produced motor as well as sensory paralysis in many instances. Reports are not infrequent, which

indicate that motor function has never returned after such injections.

Weir Mitchell's practice in the treatment of this condition was to section the nerve trunk. Pitres practiced this operation in a case of a painful lesion of the tibial nerve. The posterior tibial was sectioned at the level of the internal malleolus below the point of origin of the main muscular branches. This procedure relieved the pain in the sole of the foot. On the other hand, Sicard sectioned the median nerve 5 cm. above the lesion and resutured it immediately with only partial relief of the pain. As has been stated, Meige and Bénisty have emphasized the importance of involvement of sympathetic fibers of the large vessels or upon the small vessels within the nerve trunk or even the sympathetic fibers in the nerve trunk may be involved. In the belief that the pain is due to involvement of the perivascular sympathetic fibers, Leriche has performed a perivascular sympathectomy for the relief of causalgia and has reported successful results. Other surgeons have recorded less favorable results. Stookey removed the perivascular sympathetic from the brachial artery in a case of median causalgia but did not obtain a complete relief until he injected the nerve trunk with alcohol. The work of Kramer and Todd and Potts would tend to throw doubt upon this method of treatment. They have shown that the sympathetic supply of the vessels in the extremities comes from the adjacent nerves and is therefore segmented. In the arm these fibers arise from the musculocutaneous, ulnar and radial nerves. A localized perivascular sympathectomy such as Leriche performs would affect only a small area of the vessel so stripped. Our own experiments upon the peripheral pathways for sensation lead us to believe that there is no long unbroken perivascular pathway which transmits painful stimuli. While, therefore, this method of treatment is not anatomically sound the clinical reports of relief of pain by such an operation cannot be entirely ignored.

Lortat and Halley have reported a case of causalgia in the presence of section of the brachial artery and paralysis of the median and ulnar nerves. They ligated the median nerve with catgut and this was followed by a complete cessation of pain, vasomotor and secretory disturbances.

Many cases are upon record in which posterior root sections have been performed for the relief of causalgia. There are very few reports of successful results following this operation. In a recent survey of the literature upon the relief of pain in an extremity we have the impression that an insufficient number of roots have been sectioned.

Recently White has called attention to the possibilities of securing relief of causalgic pain by paravertebral injections of novocaine followed by alcohol. By such an injection an attempt is made to block the sympathetic rami. As yet, no results of this procedure have been reported in the treatment of causalgia.

As long as the pathogenesis of causalgia remains obscure it is obvious that no one surgical procedure may be recommended as the only completely successful method of treatment. At present it would seem that resection and suture of the nerve trunk above the lesion, as advocated by Weir Mitchell, is the most efficient.

# THIS MONTH'S CONTRIBUTORS

ABEL, OLIVER, JR., M.D., St. Louis.
Med. Consult., Soper-Mills Clin.; Att. Phys., Barnes, De Paul & St. Louis City Hosp.

BABCOCK, W. WAYNE, M.D., F.A.C.S., Phila.
Prof. Surg. & Clin. Surg., Temple Univ.; Surg.-in-Chief, Temple Univ. Hosp.; Surg., Phila. Gen. Hosp.; Author: "Text Book of Surgery for Students and Physicians," Phila., 1928.

BEIGLER, SYDNEY K., M.D., Detroit.
Att. Surg., North End Clin.; Assoc. Surg., St. Joseph Mercy Hosp.; Cons. Surg., Le Petite Fleur Villa.

BISGARD, J. DEWEY, M.D., Ann Arbor, Mich.
Instr., Univ. Mich. Dept. Surg.

BLOOM, ARTHUR R., M.D., Detroit.
Roentgen., North End Clin.

BOGART, LEON M., M.D., Flint, Mich.
Att. Staff, Hurley, St. Joseph, & Woman's Hosp.

BROWDER, JEFFERSON, M.D., B'kln.
Asst. Clin. Prof. Surg., Instr. Neurol., Long Island Coll. Med.; Neurosurg., Methodist, B'kln., St. John' , King's Co., & L. I. Coll. Hosp.

CHETWOOD, CHAS. H., M.D., F.A.C.S., N. Y.
Att. Urol. & Dir. of Serv., French Hosp.; Cons. Surg., Bellevue Hosp.; Cons. Urol., Knickerbocker, St. John's, & White Plains Hosp.; Author: "Practice of Urology," N. Y., Ed. 4, 1927.

CRAWFORD, ALBERT S., M.D., F.A.C.S., Detroit.
Neurol. Surg., Henry Ford Hosp.

DARNALL, WM. EDGAR, M.D., F.A.C.S., Atlantic City, N. J.
Gynec., Atlantic City Hosp.; Surg., Max & Sarah Bamberger Home.

DAVIS, JAMES E., M.D., Ann Arbor, Mich.
Prof. Pathol., Detroit Coll. Med. & Surg.; Cons. Pathol., Mich. State B'd. of Health.

DAVIS, LOYAL, M.D., PH.D., F.A.C.S., Chicago.
Assoc. Prof. Surg., Northwestern Univ. Med. School; Att. Neurol. Surg., Passavant Mem., Michael Reese & Wesley Mem. Hosp.; Cons. Neurol. Surg., Edw. Hines Jr. & Mem. Hosp.

EDDY, HOWARD C., M.D., Cleveland.

FRANKEL, SOPHIE, B.S., N. Y.

FREEDLANDER, S. O., M.D., F.A.C.S., Cleveland.
Assist. Prof. Surg., Western Res. Univ.; Asst. Dir. Surg., Cleveland City Hosp.

FURNISS, H. DAWSON, M.D., LL.D., F.A.C.S., N. Y.
Cons. Gyn., Post-Grad.; Fifth Ave.; New Rochelle; St. Agnes, White Plains; Holy Name, Teaneck; Hackensack; All Souls, Morristown; Cons. Cystoscop., N. Y. Infirm. Women & Child.

GURD, FRASER B., M.D., F.A.C.S., F.R.C.S., Montreal.
Lect. Surg., McGill Univ. Med. School; Assoc. Surg., Montreal Gen. Hosp.; Author: "Infection, Immunity & Inflammation," St. Louis, 1924.

HAYES, BASIL A., M.D., F.A.C.S., Oklahoma City.
Asst. Prof. Urol., Univ. Oklahoma.

HINTON, J. WM., M.D., F.A.C.S., N. Y.
Assoc. Prof. Surg., N. Y. Post-Grad. Med. Sch. & Hosp.; Assoc. Vis. Surg., Bellevue Hosp.

KAMIKAWA, KAZUNORI, M.D., Nagoya, Japan.
Asst. Surg. Dept., Nagoya Med. Univ.

KILDUFFE, ROBT. A., M.D., F.A.S.C.P., Atlantic City, N. J.
Dir. Lab., Atlantic City Hosp.; City Bacteriol., Atlantic City; Pathol., Atlantic Co. Hosp. Tub. Dis.; Author: "A Manual of Clinical Laboratory Procedure," St. Louis, 1926; "Pathology, Bacteriology, and Applied Immunology for Nurses," N. Y., 1926; "The Clinical Interpretation of the Wassermann Test," Phila., 1926; "The Clinical Interpretation of Blood Chemistry," Phila., 1927; "The Clinical Interpretation of Blood Examinations," Phila., 1931.

LAZARUS, SYLVAN D., M.D., B'kln.
Att. Phys., Kingston Ave. Hosp.; Att. Pediat., Bushwick Hosp.; Assoc. Att. Pediat., Jewish Hosp.

METTENLEITER, M. W., M.D., N. Y.
Asst. Surg., West Side Hosp.

MEYER, KARL A., M.D., F.A.C.S., Chicago.
Assoc. Prof. Surg., Northwestern Univ. Med. Sch.; Att. Surg., Cook Co. Hosp.

NARAT, JOSEPH K., M.D., Chicago.
Att. Surg., Lutheran Mem. & Norwegian American Hosp.; Assoc. Surg., St. Eliz. Hosp.

NEWELL, WILBER S., Syracuse, N. Y.
Prof. Obst. Nursing, Crouse-Irving Post Grad. Sch. Nurs.; Att. Obst., Crouse-Irving Hosp.

NIESSEN, H., D. Med., Frankfort on the Main, Ger.
Asst., Schmieden's Clin.

NUTT, JOHN J., M.D., F.A.C.S., N. Y.
Prof. Orth. Surg., Polyclin. Med. Sch. & Hosp.

PENDERGRASS, ROBT. C., M.D., Americus, Ga.
Roent., Wise, Smith & Anderson Clin.; Wise San.; Americus & Sumter Co. Hosp.

POLLOCK, LEWIS J., M.D., F.A.C.S., Chicago.
Prof. Nerv. & Ment. Dis., Northwestern Univ. Med. Sch.; Att. Neurol., Passavant Mem., Michael Reese & Wesley Mem. Hosp.

POTTS, W. J., M.D., F.A.C.S., Oak Park, Ill.
Instr. Surg., Rush Med. Coll.; Assist. Att. Surg., Presbyterian & Child. Mem. Hosp., Chicago.

ROSI, PETER A., M.D., Chicago.

RUSH, H. LOWRY, M.D., Meridian, Miss.
Surg., Rush's Inf. & East Miss. Insane Hosp.

RUSH, LESLIE B., M.D., Meridian, Miss.
Surg., Rush's Inf. & East Miss. Insane Hosp.

SAITO, MAKOTO, M.D., Nagoya, Japan.
Head Surg. Dept., Nagoya Med. Univ.

SELMAN, JULIUS J., M.D., Cleveland.
Dem. Med., Western Res. Med. Sch.; Sr. Asst. Med., Mt. Sinai Hosp.; Vis. Phys. Med., City Hosp.

Shelley, Harold J., M.D., F.A.C.S., N. Y.
Assist. Att. Surg., St. Luke's & Knickerbocker Hosp.

Thompson, J. W., M.D., F.A.C.S., St. Louis.
Surg., Soper-Mills Clin. & St. Louis City Hosp.; Assoc. Surg., St. Luke's & De Paul Hosp.

Ward, Grant E., M.D., F.A.C.S., Baltimore.
Asst. Clin. Surg., Johns Hopkins Med. Sch.; Asst. Disp. Surg., Johns Hopkins Hosp.; Instr. Surg. & Surg. Anat., Univ. Md.; Vis. Staff, Church Home & Inf.; Rad. Therap., Md. Gen. Hosp.; Vis. Surg., Franklin Sq. Hosp.

Wolepor, Ben, M.D., Montreal.
Outdoor Dept. Gen. Med., Royal Victoria Hosp.

Wruble, Joseph, M.D., Detroit.